THE

ELECTRICAL REVIEW.

VOL. XLI. AUGUST 6, 1897. No. 1,028.

CONTENTS:

	PAGE
The Employers' Side of the Engineers' Strike	169
New Electric Carriage (*illustrated*)	171
Hydro-Electric Power Stations in the United States	171
High Speed Self-Lubricating Steam Engines	172
The Rushmore Multi-Circuit Arc Machine (*illustrated*)	173
Advice from America on Electric Traction	174
Burke's System of Cable Telegraphy	175
An Efficient Electric Bicycle Lamp (*illustrated*)	175
A New Basis of Dynamo Calculation and Classification	176
Action of Solenoids on Cores (*illustrated*)	177
Induction in Short Soft Iron Magnets (*illustrated*) ...	177
Steaming Conditions in Engines and Boilers	179
Correspondence:—A Strange Magnetic Freak	180
Commutator Bars	180
Electric Pumping Plant	181
Business Notices, &c.	181
Electric Lighting Notes	182
Electric Traction and Motive Power Notes	183
Telegraph and Telephone Notes	184
Contracts Open and Closed	184
Notes	185
City Notes	186
Traffic Receipts	188
Share List of Electrical Companies	189
The Limits of Speed in Working Submarine Cables as Affected by Faults or Leaks, and by the Proportions of the Materials	190
Electricity *v.* Shafting in the Machine Shop	193
Electricity in the Modern Machine Shop	194
Reviews:—The Calculus for Engineers	194
The Induction Coil in Practical Work	195
Electromoteurs et Leurs Applications	195
Minutes of Proceedings of the Engineering Association of New South Wales	195
Journal of the Institution of Electrical Engineers. No. 127	195
Fatal Accident at the Bournemouth Electric Supply Station ...	195
New Patents and Abstracts of Published Specifications ...	196

THE

UNIVERSAL ELECTRICAL DIRECTORY

(J. A. BERLY'S).

PRICE 6/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1897.

PRICE 6/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW. LONDON.

Telegraphic Address: "AGENCY, LONDON." Code A B C. Telephone No.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To all *other countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s. or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

THE EMPLOYERS' SIDE OF THE ENGINEERS' STRIKE.

WE understand that an appeal has been circulated to the Manchester employers who have not yet taken action on the 48 hours demand. The object of the appeal is to give a clearer appreciation of what the 48 hours really means. to explain the real significance of the demand, and to help to defeat it.

The federation of employers wish to enlist all firms and put a speedy stop to the struggle, arguing truly that if all the men were on strike in place of about a third of them only, the funds would suffer a much more rapid reduction and the strike would quickly collapse. If the masters are defeated the terms imposed will be most onerous, and on these grounds alone they consider they are right to object. They state that argument with the labour leaders is useless, To this we are compelled to assent, for we have an instance before us where argument was absolutely declined by them, and very serious inconvenience caused to a firm who were willing to concede a change in a short time.

Another argument made use of is that if the men lose, they will enforce the 48 hours against those firms who have not, so far, attempted to stand out. We do not think much of this argument. If the men lose, we fancy all the present weak firms who have given way will simply return to the old hours again. The damage to trade will have been so great, that plenty of men will be idle, and if the men lose, they will lose all along the line. To those firms who cannot join the Association of employers, the request is made that overtime shall be stopped. In this respect, we believe, many firms have already stopped overtime, and the result has been that men who have been earning up to £3 a week now only earn the rate. On this point of overtime, an old engineer tells us that in the dispute of 1851 the leaders of the men themselves actually left non-overtime shops and got work in overtime shops, while all the time preaching and agitating against overtime. In this present strike, too, the trouble seems to us entirely one of the leaders making. The men were comfortable enough, and did not wish for a change. The appeal states that facts show that the eight hours' output is not equal to that of a nine hours' day. Prime cost books and the productive results of shorter hours show this, theorists to the contrary notwithstanding, and, quoting from the appeal, "*we are sure your own experience will confirm this.*" This latter is our own contention, and forms the basis of our own argument, that we believe the masters would not object to the eight hours' system if they could get from the men six hours work. This is no theory of ours, but actual experience of the working of really competent men who simply will not work. One shop is cited as being stated to be an eight hours' success. It is averred that this shop has been

systematically nursed, and in fact, that the men have been very much driven to get out the work in the eight hours to equal the former output. But if a 48 hours' work is general, such slave driving will be impossible in this now odd one shop. There is a good deal of point in this argument.

In good times the hours worked as a rule throughout the country are about 63, including overtime, and if overtime were really intended to be abolished, some 31 per cent. more men would be required. Where, it is asked, are these men to come from? The A.S.E. has restricted apprentices, and the men cannot be found. We know as a fact that no men worth a penny an hour were lately to be procured. The overtime sentimentality is a palpable mistake, and we have this from members of the Union itself—decent, respectable men, who are anxious to make overtime, but who now have to pay heavy levies in order that the strikers may be idle. The employers' appeal finally turns to the question of wages, and it is shown that the increase amounts to $14\frac{3}{4}$ per cent. on Manchester rates, and 21 per cent. on London, and that the wage increment by no means represents the total increased cost of the eight hours' system. An appendix is added showing the rise of wages, &c., since 1891, which would seem to show that the men's statement that they have only had a 2s. rise since 1891 is a myth.

We have thought over the whole matter with a mind as unprejudiced as possible. We have taken the opinion of employers and employed, and we are compelled to think that in this present dispute the men have been badly advised by their leaders, and that the only persons who are getting anything out of the trouble are the leaders and agitators, and the idle and dissolute.

Like a good many other things, the A.S.E. has outlived its necessity. The time has passed when the abuses it helped to rectify could again rear their heads. And when any society or association is convinced that its usefulness is over, then has the time come for it to endeavour to show a cause for its existence. In the present case this cause has been worked up on the eight hours' system.

Working Results on Electric Tramways.

It is always interesting to get plain talk from go-ahead tramway men, and the *Street Railway Review* therefore does a good deed in setting up a "symposium" on the comparison of electric lines with one another, according to the cost per car mile or per passenger. The symposium, however, is all one way, a practically unanimous opinion being expressed in favour of adopting the cost per car mile as a means of comparison. It is not very easy to see exactly what the contributors to, or the orginators of, the symposium are driving at; for all practical value in comparison of lines they might as well take the average house rent paid by the respective motor men, or the comparative number of redheaded conductors. Cost per car mile is readily arrived at; but where i the fairness of comparing line A, which runs through a scattered district, and has a passenger density of, perhaps, five per car mile, with another line, B, in a populous town carrying an average of 10 or 12 passengers per car mile all the year round? Yet both may have the same working costs per car mile, for everyone knows that, proportionally, it requires little, or no more, outlay of energy to run cars with a full load than those that are empty. There is all the difference in receipts and net balance however. This tends to show that it is of no value to take simply one side of the account without regard to other conditions, unless the idea is to limit comparison strictly to cost. Tramway shareholders are naturally anxious to see the costs reduced as low as possible, but they also like to have the cars well loaded. It is not, however, any fairer to take the comparative number of passengers on different lines as a means of arriving at their prosperity or otherwise. Some of the passengers may be "dummies" or "dead heads," some half-rate; nearly all may be paying different fares according to length of travel; some may be counted twice over, if they pay for a continuation of route. Even adopting the car fare as a unit does not give satisfaction, for most lines have a variety of fares according to distance, and it would be difficult if not impossible to reduce them to a standard or typical fare representing the average passenger. It is, of course, easy to see the object of choosing either the car mile or the passenger as a basis of comparison. In the first case, it costs a definite amount to run a car for a mile, and the less this amount the better the line; in the second case, increase of passengers means increase of receipts and therefore a better line also. A combination of the two seems advisable, but some difficulty will be found in effecting it. Certainly it seems of no use taking the passenger unit, a fairer way to our mind is to average the passenger density per car mile over the whole year. On English lines this varies from 5 to 12, or even more; and an equable comparison can only be made between those lines which have approximately the same average annual density. Then the cost per car mile gives a tolerably fair notion of the respective quality of management and design in any two tramway systems. Taken altogether, and regarded as a form of electricity supply, the operation of electric tramways occupies a very peculiar position. The cars have to be run in more or less complete system whether passengers and payment are forthcoming or not. It is equivalent to the position of an electric lighting company which has to keep alight a certain minimum number of its customer's lamps, which are only paid for when they are actually being used! We wonder what electric light supply engineers would say to such a method of obtaining revenue! If electric tramways were on a level with electric lighting companies, they would only be available to a favoured group of season ticket holders who would pay a small regular annual fee, and in addition a reduced fare each time they used the cars. Dick, Tom, and Harry in the street would have no chance of jumping on for a penny ride. All which seems to show that electric tramways are even far greater public boons than electric lighting, also that the Wright maximum demand indicator may, by and by, have to be adopted also to purposes of a personal and portable nature in connection with the comparative use of electric tramcars by individuals!!

Turner's Field Magnet.—An improvement in field magnets of dynamo-electric machines and electric motors invented by Mr. Charles P. Turner, of New York, was recently described in the *Scientific American*. The magnetic permeability of iron used in the field magnet cores of dynamos and motors is much affected by the presence in the iron of carbon, phosphorus and other impurities, which decrease the power of the field magnets for creating lines of force. Alloying iron with other metals also causes losses which are considerable. This invention is designed to partly or wholly prevent these losses and thus increase the efficiency of the dynamo or motor. The invention is extremely simple. It consists in the combination with the polar extremities of the cast or wrought-iron field magnet of a facing of pure iron on the surface adjacent to the armature. The pure iron is deposited electrolytically, and being homogeneous throughout, insures greater permeability than can be realised in the best forgings or castings.

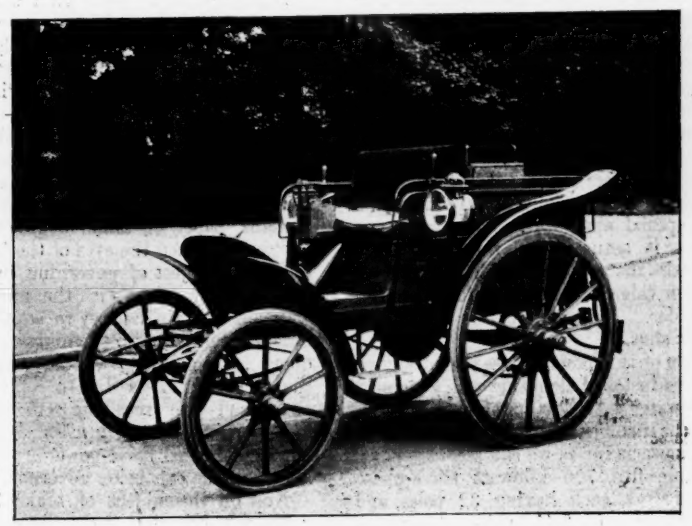
NEW ELECTRIC CARRIAGE.

To record the advent of an electrically-propelled vehicle which in practice and not only in theory is ahead of anything we have yet seen is a pleasure, although we regret that it should be a Belgium firm of accumulator manufacturers which has achieved this measure of success in the solution of a much-vexed question.

Our representative had the pleasure of calling on L'Electrique (Société Anonyme) of Brussels, and was invited by them to inspect their carriage thoroughly and to witness its performance.

The battery, placed under the seat of the carriage, consists of 48 2-volt cells measuring 170 × 80 × 260 mm., each weighing complete 9 kilos, the weight of the electrodes being 6½ kilos. The plates are a special type patented by the company, and are of the Plante form, they have a capacity at a discharge rate of 18 amperes (1½ amperes per lb.) of 6 ampere-hours per lb. The cells are charged with a current of 25 amperes at 110 volts, the operation occupying 3 to 3½ hours. The cells are completely discharged when the voltage drops below 86 volts.

Apparently the only danger of short circuit would arise from actual contact of the electrodes caused by the jolting and vibration on rough and badly-paved roads, and this is prevented by the use of celluloid separators surrounding the positive, while splashing is prevented in a similar manner by perforated sheets of celluloid resting above the electrodes and by the depth of the boxes themselves.



The motor, specially designed by the company's engineer, weighs 125 kilos, is excited in series, and runs at 1,750 revolutions, this speed being transmitted to the driving wheel by reducing gear and chain, while differential movement of the driving wheels is attained by the use of an intermediate clutch.

The carriage is a four-wheeled dogcart seating four persons, and weighs, with battery and motor, 1,100 kilos.; it can be driven between 40 and 50 miles, at a rate of 10 miles an hour, without recharging.

Our representative was driven through Brussels, where cobble stones still obtain as paving material in all but the principal streets, and he was struck by the perfect control of the vehicle, the ease with which it mounted fairly heavy inclines, and the certainty in stopping and starting. During the run the driver stopped dead both going up and going down hill, and started again either forward or backward as desired, the operation being effected instantaneously.

The cells had been in use some considerable time, but in those which our representative examined there seemed to be no trace of deterioration, and he was assured that the life of the cell would certainly be not less than two years. When it is considered that the driving wheels were the ordinary carriage type with solid rubber strip over the iron tyre, it seems to us that even better results would be possible with pneumatic tyres, and we can certainly congratulate the directors of L'Electrique on having attained such good results.

HYDRO-ELECTRIC POWER STATIONS IN THE UNITED STATES.

Hardly a week passes by without the beginning or the completion of some new water-power installation in the United States, for supplying electric light and power in populous districts not necessarily by any means close to the source of energy.

Not long since (Electrical Review, May 21st, 1897, page 703), we described and illustrated the proposed new and artificial Niagara in the North of New York State, where a project supported both by English and American capitalists is now in course of being carried out, with the idea of diverting some part of the St. Lawrence river across country into one of its own tributaries that joins the main stream further down at a much lower level. The contracts call for the installation of canals, plant and machinery, capable of developing 75,000 horse-power; all to be erected within the next 18 months or so. This enterprise alone, therefore, promises to rival the Niagara power station at the outset, whatever developments may await the latter in the future.

We have also dealt fully with the large power transmission at Fresno in the San Joaquin Valley—large at least in the sense of high pressure employed, this being no less than that due to a head of 1,400 feet. A much smaller scheme in regard to water pressure used—a low water tension scheme, in fact, not a high water tension one—is now on the point of completion on the Mississippi at St. Anthony's Falls, between St. Paul and Minneapolis. This hydro-electric power house has been primarily designed and built for the purpose of operating the St. Paul and Minneapolis electric tramway systems, but as only a part (perhaps half) of the output equal altogether to some 10,000 H.P. will be required for electric traction, the remainder will be sold or utilised in other ways.

St. Paul and Minneapolis—usually known as the Twin Cities—practically form one large urban district with a population of nearly half a million, perhaps a little more than half that of Manchester and Salford. Yet they have no less than 225 miles of street railway or tramway—nearly *four times* as much as our cotton city and its neighbour. Out of this length, only six miles are worked by cable, the rest is all electric, and has been operated up to the present time from three steam power houses, having a total output of some 5,000 H.P. These will be shut down when the hydraulic plant is completed.

The available head of water will be maintained at 20 feet, but the flow of water sometimes reaches 60,000 cubic feet per second. The minimum is only 2,000 cubic feet, corresponding to 4,000 H.P. The average flow at Minneapolis may be taken at 6,000 cubic feet. To obtain the necessary head a dam has been built across the river bed; in plan the dam has an inverted V-shape, the apex pointing up stream. At one extreme side there is first a log sluice next to the bank for timber to pass down, then a "bear-trap," or movable gates actuated by hydraulic pressure for regulating the head of water, then the main dam in two sections; one 366 feet long and 29 feet high, standing 13 feet above the river bed; the second is 444 feet long and 14 feet above the river bed. Both sections are of solid masonry construction, but the first has a coping of granite, the second one of steel. The up-stream face will, when finished, consist of stone filled cribwork in front of the perpendicular masonry work of the dam, with an inclined timber floor over which logs and ice may pass in the winter. The down-stream face consists of a series of steps in the masonry, below these being an apron 15 feet wide made of iron rails laid in cement.

Between the second section of the dam and the further bank of river is situated the power-house: and here are also

two other "bear trap" or head level adjusting gates with a further short section (50 feet) of masonry dam. The "bear trap" gates are of the hinged type, each being 50 feet in length, of steel construction decked with wood: they are secured to massive stone piers 8 feet thick, 40 feet long down stream, and 25 feet high; the gates are hinged at the base to these piers, and move up or down between them.

The power-house measures 250 feet in length by 57 feet in width, excluding the turbine chambers, which are 40 feet wide and extend nearly the full length of the main building. The entire structure is fireproof, the framework and roof being of steel, while the walls are built (so we learn from the *Street Railway Journal*, to which we are indebted for all these particulars) of hollow salt glazed tile 16 inches thick. The roof is covered with tiles, upon which is placed cement and roofing slate over all. The height of the main walls is 35 feet, and to the roof ridge is 51 feet. Plenty of light is obtained from large windows on both sides of the building —there being no less than 15 to the main chamber itself, each 25 feet by 12 feet. The switchboard gallery at the back of the building has 10 windows, each 4 feet by 7 feet. Of course, electric light is used throughout, and we are also informed that the building will be heated by electricity—the rather curious statement being made that "1,000 H.P. *per day* will be required during the winter season." For the latter purpose a 20-ton overhead crane travels the entire length of the building, it is operated by hand from a gallery underneath the crane girder and attached to it.

The capacity of the entire plant is 10,000 H.P., ten units of 1,000 H.P. being installed. Each unit consists of one 1,000-H.P. generator coupled to a horizontal shaft rotated by four Victor turbines each of 250 H.P. The turbines (and also, of course, the generators) run at 130 revolutions per minute, the former have each a diameter of 42 inches. They are governed by special apparatus, comprising three cylinders, the uppermost is actuated by the centrifugal governor balls, and it works the middle cylinder—which, in reality forms a large piston valve arrangement for operating the lowest or main cylinder. By means of the latter the wheel gates are opened or shut.

It is stated that the plan of this power-house is so designed that a steam engine may be installed alongside each generator for use when the head of water is too low for efficient service, or in case of accident to the turbines; but no provision seems to be made for a boiler house as far as we can see.

The generators include five 700 kilowatt three-phase revolving armature alternators, each having 32 poles, and generating current at a pressure of 3,450 volts. There are also two 700 kilowatt 8-pole 600-volt direct current generators, used for local supply to the street tramway service. The alternators weigh each, complete, about 40 tons, the direct current machines about 55 tons. The three-phase machines are excited with current from two 6-pole 600-volt direct current generators, driven by separate turbines.

Current is taken to St. Paul (about 10 miles distant) at a pressure of 12,000 volts. Three sub-stations are erected, two in Minineapolis and one in St. Paul. At the former, the current is reduced and transformed by 600 kilowatt rotary converters from 3,450 volts alternating to 580 volts direct. In the St. Paul station there are two such converters reducing and transforming from the still higher pressure of 12,000 volts alternating. The step-up transformers at the main power house for supplying St. Paul are six in number, each having a capacity of 233 kilowatts. Air blast from a 50-inch blower is used for cooling.

The entire cost of this installation is stated to be about £100,000, of which some £60,000 has been used for the electrical equipment.

(To be continued.)

HIGH SPEED SELF LUBRICATING STEAM ENGINES.

It is very refreshing to find the author of a paper* on high speed steam engines speaking of the *part* his firm has taken in their development. If Mr. Alfred Morcom had followed precedents, he might have ignored the competitive firms altogether, and left his hearers to tax their memories as to the existence of any other kind soever of "high speed" steam engine. The French call such engines "à grande vitesse angulaire," and Raworth calls them "short stroke," a description which seems to define the class rather better than the others, because it clearly does not include Laval and Parsons, which the title, "high speed," certainly does.

The keynote of the paper is "forced lubrication," to which is ascribed the Belliss-ful state of noiselessness attained by the engines so fitted, which condition is maintained even with slack bearings; but Mr. Morcom does not mention the fact that noise can be cured just as easily with a common oil can, if it be kept running constantly.

The fact is, the pressure exists in the pump, but not in the bearings; in the bearings it is simply oil, and plenty of it, much more than is possible in a constant thrust engine; but even in a constant thrust engine there is enough for practical purposes.

Both Mr. Robinson and Mr. Morcom state that the wear in their respective engines is practically nil, and nobody appears to doubt it, except Mr. Patchell and the Bolton engineers, whom nothing less than the rack will ever convince.

A good point is made on the subject of effective horse-power *versus* indicated horse-power; it is useless to pay for economy in the cylinder and to throw it away in the crank, but that is what they do at Bolton; they sell their customers an acre of steam engine, the principal use of which is to produce immaculate diagrams—and paper horse-powers—which are, comparatively speaking, donkey powers at the line shaft. If they used a higher mean pressure, both the engine and the effective horse-power would cost less.

Possibly in the course of the next century a copy of Willans' paper on steam engine trials may find its way to Bolton, and then the eyes of the blind may be opened.

On the subject of governing by automatic expansion, Mr. Morcom provides us with the usual high speed amusement, and calls Captain Sankey to support him. He says: "The disadvantages due to the higher initial pressure with consequent leakage, the *frictional losses due to compression*, and the increased losses due to liquefaction are clearly pointed out; and the resulting efficiencies of the two modes of governing, *especially when determined by work done*, and not by indicated horse-power are shown to be not greatly in favour of the expansion governor."

Now on the subject of brake H.P. Captain Sankey said: "The true criterion of the engine's performance ought, however, to be the water consumption per brake H.P., and not per indicated H.P. . . . such a question, however, does not enter into the scope of this paper."

This is all Captain Sankey says on the question of brake H.P. in connection with expansive governing, and on the subject of compression he says *nothing*. The Lord deliver us from our friends! The fact is that Captain Sankey's paper was purely scientific, and as a scientist he stated the case impartially from the point of view of pure automatic expansion, but there is no such thing in this world; even the Corliss gear begins to throttle a little at *light load*, and the automatic shaft governor, which is the only practical expansion governor for high speeds of rotation, throttles very much. As Captain Sankey pointed out, this is just what is wanted to cure the excessive condensation at light load.

The reasons, or some of them, which led Mr. Morcom to adopt expansion governing, are very curious, for instance: "The circumstance that the Crescent engine is arranged with both valves driven by a single eccentric, naturally led in the direction of expansion governing, owing to the ability of the governor to act simultaneously on both light and low pressure valves."

Experientia docet. Mr. Morcom found that the governing was good, but the economy was not there, as indeed it could not be. The volume swept by the L.P. piston at cut-off must necessarily be a little in excess of the volume of the H.P. cylinder—if it be more, the drop from H.P. to receiver will be excessive. If it be less the H.P. will exhaust into a receiver having a higher pressure. A few years ago we had the opportunity of seeing this fact demonstrated in an engine with automatic expansion on the H.P., and hand expansion on the L.P. The best point of cut-off on the L.P. was about $\frac{7}{16}$ths stroke, and any variation from this, either up or

* Read by Mr. A. Morcom at the Summer Meeting of the Institution of Mechanical Engineers, held at Birmingham.

down at any load, immediately increased the discharge from the air pump.

In Table 6, we have the results of experiments to determine the relative values of expansion and throttle governing, in which the throttle valve wins easily, as it naturally would when pitted against an expansion gear which controlled the admission and exhaust of both cylinders.

When we consider that the Corliss engine has been in our midst for 30 years, and has produced results with automatic expansion which are unimpeachable, and with the cut-off acting on the H.P. admission valve only, we cannot understand why Mr. Morcom did not send his Table 6 to Woking rather than to Birmingham. But wisdom is justified of her children; if one cannot obtain the luscious looking grapes, it is far better to set them down as sour than to waste one's strength in jumping.

But Willans proved, if it needed proving, that the grapes were all right. Referring to the steam engine trials, and comparing trials K_2 and K_3, we find the following results:—

Ref. No.	K_2	K_3
Rates of expansion	4·82	10
Boiler pressure absolute	114·67	114·74
Mean pressure	38·85	25·81
Pounds of steam per 1 H.P.	16·97	15·83

But if the power had been reduced by throttling, we know by the Willans law that the 15·83 of K_3 would have been about 17·5.

These results were obtained with an engine in which the cut-off was varied on the admission valve only, so the evils attendant on over compression did not come in; therefore, to be logical, Mr. Morcom ought to debit the loss of economy in his experiments to his valves and not to automatic expansion.

Captain Sankey has now produced a combined throttle and expansion governor suitable for the Willans engine, but even this somewhat complicated gear apparently does not produce the results obtained by Mr. Willans. Nevertheless, the whole drift of Captain Sankey's paper was to the effect that automatic expansion is better than throttling, but that it is not always worth while to go to the expense and trouble of using it.

Mr. Raworth pointed out in the discussion, and it has since been confirmed by Messrs. Browett, Lindley & Co., that an automatic shaft governor costs actually less than a throttle governor, and the evidence of users is certainly in favour of the shaft governor under the head of maintenance. As to Corliss gear the evidence is universal and conclusive, that it never causes the slightest anxiety; even the catch points do not wear appreciably.

Possibly we have taken Mr. Morcom too seriously in criticising his paper as a contribution to the science of the steam engine.

THE RUSHMORE MULTI-CIRCUIT ARC MACHINE.

The tendency of the past few years has been towards a steady increase in the capacity of arc light machines, so that whereas five or six years ago an 80-lighter was looked upon as a remarkable achievement, to-day 100 and 120-lighters are getting to be quite common, and machines of still greater capacity are promised. The tendency is also strong towards the designing of such large arc machines, so that the output can be divided into independent circuits.

In line with this idea is a multi-circuit arc dynamo recently constructed by Mr. S. W. Rushmore, of Jersey City, N.J., and described in the American press, which is capable of supplying a number of independent circuits each automatically regulated from full load to short circuit, constituting, as it were, a true combination of a number of small machines with all the advantages that sub-division affords, but without its disadvantages.

The new machine is very simple in construction, and has a large ring armature surrounded by a multipolar field. The field is somewhat different from the ordinary construction in that the magnet poles are not secured to a common field ring, as in usual practice, but are arranged in pairs, each magnetically separated from the others. The armature and the poles are so proportioned that the section embraced by a single pair of poles will have sufficient capacity to supply a circuit of arc lamps at the maximum voltage; and thus for each additional circuit the armature is made of greater size and there will be an additional magnet or pair of poles. In short, it is a number of arc machines incorporated in a single unit with an armature common to all.

In the first machine constructed on this plan some years ago, three brushes were employed for each section with one brush between the poles of each magnet and two brushes outside of the poles, the central brush forming one pole of the circuit and the outer brushes joined together to the other pole. This arrangement worked very well so long as the loads on the different sections remained the same, but when it was attempted to greatly vary the number of lights on one section. the brushes collecting currents for other circuits under other poles would flash badly and there was a great falling off in the capacity of the machine.

After studying the matter carefully, Mr. Rushmore concluded that this interference of the different sections was due to the current in the armature causing or allowing the flux from one section to flow to the other sections, and he concluded that the trouble would disappear if the armature flux due to the current in each circuit could be kept within its section, and he therefore arranged the machine with brushes to collect the current from the armature under but a single pole of each pair of magnets instead of under both poles. With this arrangement it was found that as much current could be collected from a section of the armature under a single pole as under both poles, while the idle pole served to keep the flux from flowing to the other sections; and no matter how much current was drawn from the armature under one section or separate magnet, there was no effect upon the other sections, and each section and pair of brushes would supply an independent circuit with varying current or pressure, entirely independent of all other sections.

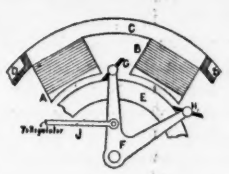


Fig. 1

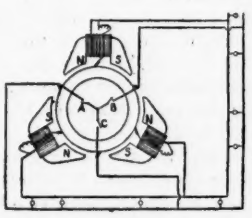


Fig. 2

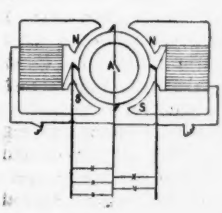


Fig. 3.

In fig. 1 is shown a section of the machine with a ring armature with poles A and B connected by yoke piece, C; D, D are non-magnetic sections joining a magnet with other similar magnets to form a complete field; E is a section of the armature, and F a brush rocker carrying brushes G and H, which are adapted to include between them the armature coils under pole, B; J is a bar or lever connected to the regulator.

When the circuit supplied from the brushes is at its maximum voltage, the brushes will be shifted to a position with the pole, B, nearly central between them, and as lamps are cut out and less voltage is required, the regulator will shift the brushes towards pole, A, thus distorting the field from pole, B, to keep down the voltage, as in bi-polar machines. As the current in the armature under pole A, is only the small amount that will find its way around the armature from brush, G, to brush, H, there will be little or no distortion of the field under pole A, and there will be no interference with the working of the other sections.

It has been found that machines constructed on this principle have very little tendency to flash and have such a wide inherent regulation that very little work is required of the regulator. The machine may be built with a large number of poles to supply a number of circuits and connected directly

to the engine. In appearance it is practically the same as common types of multipolar machines, except that for each pair of poles there is a regulator to shift the brushes of that section.

This arrangement is not limited to arc machines, but may be applied to any service where it is desirable to have a single machine supply current at two or more different pressures, as applied to incandescent lighting and railway work. The machines may be built in large units to deliver the entire output at a single voltage, or at as many different voltages as there are pairs of poles surrounding the armature, as required. Thus, one or more sections of the machine may supply the main station buss, while other sections may supply feeders and be compounded to give any range of pressures required up to double the voltage of the main buss, thus dispensing with boosters and special high pressure dynamos, and improving the economy of the plant.

This is shown diagrammatically in fig. 2, in which A, B, and C are switches adapted to cross connect the brushes so that the current may be collected directly under a single pole of each section, or under as many poles as conditions may require.

Fig. 3 shows the arrangement as applied to the three-wire system, in which case it is practically two independent machines connected in series, and the load may be entirely removed from one side of the system without in any way affecting the other side, which may be fully loaded. In fig. 3, A is a switch adapted to connect the brushes so that the current would be distributed equally throughout the armature, and this switch would be opened only when the system was so badly out of balance as to make it necessary to collect current under one pole, as already described.

ADVICE FROM AMERICA ON ELECTRIC TRACTION.

The wise man always listens to advice, but he need not, and should not, always follow it throughout. The best plan is to adopt what seems new and good, but cast aside whatever is not consonant with experience under approved ruling conditions.

In matters of tramway management, we have—speaking generally—the very alphabet of success to learn from the United States, in regard to enterprise and progress: this would be manifest to our readers from the brief abstract we published lately of a paper by Mr. Carr on "How to Make Electric Railways a Commercial Success." Moreover, we can take with profit from our American cousins a whole heap of advice on technical traction matters, especially in the direction of motor and controller design.

But there are opinions held and advocated very strongly across the Atlantic in regard to design of track, power house, and overhead work that we know instinctively on this side to be absolutely unsuitable, if not erroneous, for the conditions that prevail with us. Take, for instance, the very paper above referred to, read by Mr. Carr before a Canadian engineering association. The type of track described by him as good enough for standard would never go down in an English city or town. He recommends a 65 tee rail for macadam or unpaved roadways, where an English engineer would never dream of anything but an 80 lb. girder rail: his experience is that cars rattle and jar much more on rails laid in concrete than on a less rigid roadbed—which is quite likely, but shows that the cars are not sufficiently well provided with springs.

Then in paved streets, rails are to be spiked to oak cross-ties according to Mr. Carr. In England the advocates of wooden ties are getting very few and far between, and where they exist, they chiefly recommend the use of longitudinal timbers rather than cross ties—a much more sensible method, as those will acknowledge who remember the smooth running on the old Great Western tracks, only obtained now by heavy rails and rolling stock with plenty of springs.

Of course, conditions are very different in this country to what they are in America, but it is worth pointing out these matters in order to prevent our teachers and instructors from bringing over their systems and designs *en bloc* for use on this side without any modification or allowance for "change of climate," not to say of custom also.

On the other hand, the arrangements generally adopted in the States for rail joints in the shape of fish and tie plates are much superior to what is customary with us. The fish plates employed for tramway work in America are seldom less than 30 or 36 inches long instead of the 18 or 20 inches of English practice: and never less than six fish bolts are put in, more often, indeed, 8, 10, and even 12 may be used, especially with tie plates. This is doubtless due to the experience of American engineers in heavy traction work: they found out long ago that rail joints required more attention than any other part of the track, and could not be too solid or rigid.

American power-house practice differs from the English in some few respects; for instance, forced or induced fan draught with a short iron or steel plate chimney stack is often preferred to the heavier and more substantial brick chimney so beloved of English engineers. The capability of varying the draught with the load at different times of the day, thus obtained by American practice, is an advantage of no small moment, even supposing that the fan plant costs as much as the brick chimney, and so offers no monetary saving. Moreover, the use of liquid fuel for power-house work has received much more attention in the States than here: and there are many instances in this country where the responsible designing engineers might, with advantage, study what has been done by Mr. Holden, of the Great Eastern Railway, in the matter of liquid fuel for stationary boilers. The only station we know of where trials have been made, is that at Kensington, but there must be many where storage land is cheap and skilled labour expensive, so that the saving of three-fourths the stoking staff is a consideration of importance.

In the *Western Electrician*, of Chicago, Mr. G. Whitefield Chance also enters the ranks of instructors in electric traction design. He has his country's all-prevailing opinion as to roadbed, modified, however, to this extent that "if heavy traffic is the word, put in concrete first, last, and all the time: and perhaps you may do away with ties entirely if the conditions are favourable."

We should never dream to-day of using wooden cross ties for electric tramway work. Except for drainage purposes, it is a marvel to many why our steam railways still employ them, spending heaps of money on heavier and heavier rails to gain the necessary rigidity of track for high speeds and great weights. For modern services—not for the 40 ton trains at 20 miles an hour that led Stephenson to float his track across Chat Moss—the more rigid the roadbed the better, and springs ought to be put in the rolling stock, not below the wheels. Mr. Chance speaks well of a properly designed girder rail, but thinks that most of the "foreign" ones are defective in head formation. Many undoubtedly are, having a tendency to bend over, but the leading European makers turn out also plenty of sections that are as perfect as our present experience calls for. He rightly, however, pleads for a high carbon rail in tramway practice: chemical composition ought generally to have more attention paid to it than has hitherto been the case with consulting engineers.

With regard to joints, a continuous rail must be aimed at. Cast welded joints are much cheaper than those electrically welded—American prices being respectively 17s. 6d. and 25s. for a 9-inch rail weld. In this connection it may be remembered that the copper bonding alone of an ordinary joint makes a big hole in 10s. Many, however, maintain that cast joints still require bonding, and that they only save the cost of fish-plates, &c.

There is still rather too much slap-dash about American practice in many respects, to judge from Mr. Chance's remark that creosoted wooden ducts for underground feeder cables are "standard," but seeing that the overhead wires are only beginning in the States to go underground, we can hardly expect very elaborate systems like those used in England (iron pipes, earthenware ducts, &c.) to be adopted at once. Our author's remarks on the general question of motive power are brief but apposite: he says "You may be pleased and edified to note the progress made in compressed air, gas, steam, and other motors, but experience teaches and it has not yet demonstrated these motors to be superior for urban and ordinary suburban service. The accumulator car, and compressed air motors, are worthy of study, and in certain situations these motive powers may yet find a field." A somewhat limited one we think.

On the whole, we have, as must be obvious to every fair-minded man, an enormous amount to learn from American engineers in tramway matters; their experience gained at heavy cost, and with hard work, is made available for our benefit, and the meed of thanks should not, therefore, be ungenerous. We pay it by going to the States for motors, controllers; sometimes engines; even cars; poles, too, in a few cases; while overhead fittings for English tramways have to date universally crossed the Atlantic. Perhaps the time may not be far distant when all these things will be made in England for cheapness and convenience, but the credit will even then be largely due to America for showing the way and building the rough foundations upon which English solidity and thoroughness of method will raise a superstructure of improvements.

BURKE'S SYSTEM OF CABLE TELEGRAPHY.

The New York *Electrical Engineer* of June 23rd last publishes particulars of a system recently patented by Mr. Charles G. Burke, which has for its object "the adaptation of Morse work to long submarine cables and other telegraph lines where large static capacity is an obstacle to the use of ordinary Morse signals. It also enables messages to be automatically relaid from cable to cable, thus doing away with translation and re-transmission of signals."

The transmitter is, in principle, practically an ordinary single current key so arranged that when in its normal position of rest the cable is to earth through a receiving relay, but when manipulated for signalling the relay contact is broken and the cable put to the sending battery.

When the relay is not influenced by a passing current the tongue is held by a spring against its working contact, and the armature of the Morse instrument in the local circuit remains attracted so as to press the moving paper slip permanently against the ink disc and register a continuous line. As soon, however, as a current from the cable energises the relay electro-magnet the tongue is withdrawn from the working contact, the local circuit is broken, and the Morse armature is in consequence withdrawn by its spring, causing a break in the continuity of the ink line.

Mr. Burke's object is to record *dots* and *dashes* on the slip in ink in the usual way, without sending a longer charge into the cable for a *dash* than for a *dot* signal. This he does by sending signals of dot length only at such intervals of time as will divide up the otherwise continuous ink line into lengths equal to a dot or dash, as required, in the following manner:—

Whether a dot or dash is to be recorded, the transmitting station begins by depressing the key against the battery contact as when sending a dot signal. This attracts the receiving relay tongue from the marking contact for a corresponding length of time, the Morse armature moves the ink disc away from the slip, and a break is made in the ink line equal to a dot. This, however, is not the signal to be read from the slip; the true *ink* signal, whether dot or dash, commences from the moment that the received current ceases, and allows the relay tongue to move back to its marking contact, so as to again close the Morse local circuit. If it is to be a *dot*, then a second contact with the battery is made at the sending station after the usual interval between the elements of letters (equivalent to one dot) and the current to line on arriving at the distant end throws back the relay tongue, and again breaks the Morse circuit. The recorder has only had time, after the first break of dot length, to register a dot on the slip before the second break comes and determines its length. If the first signal is to be a *dash*, instead of a *dot*, then the second current from the sending station is made to follow the first after a longer interval, *i.e.*, when the receiving Morse has had time to record a dash signal. In other words the Morse instrument makes a continuous ink on the slip until currents of equal duration from the sending station cause the relay tongue to divide it up into dots and dashes—by blank spaces of equal length—according as the interval between consecutive received currents is short or long. There is, however, an important difference between Mr. Burke's arrangement and the ordinary method of recording, viz., that, in the former, spaces between letters and words are also shown by black lines. These are much longer even than the dash signal, and it is said that practice soon enables one to detect the difference between them, and to decipher messages quickly.

The novel method of transmitting signals by hand keying would clearly not be easily mastered; but it is intended to effect this by an automatic instrument devised by Mr. Burke. It certainly seems a disadvantage not to be able to resort to the conveniences of a key for conversational purposes.

That this system requires only that the strength of the received wave be sufficiently reduced to *break* the marking contact, instead of having to move the relay tongue wholly over and produce a firm contact, is a point decidedly in its favour, but as an offset against this there is the reduced speed which the extra signal required for every letter entails. Thus: *i* requires three signals through the cable to produce two dots, and *t* two signals to form one dash, and this is so for all other letters.

It is probable that at least as high a speed is attainable when using an ordinary double current key and a polarised relay because the reversal after each dot or dash throws the relay tongue off the marking contact, and the relay may therefore be much more sensitively adjusted as the retracting spring is not required.

Again: A system in which dashes have to be recorded on the slip is clearly incapable of so high a speed as when the dot and dash equivalent are respectively produced by single positive and negative battery contacts of equal duration; as, for instance, when using a "neutral relay" on the Bright's Bell's principle—like that devised by Mr. Delany—for working a Morse instrument of the Herring type. In this instrument both dot and dash are at right angles to the length of the slip; both are made in the same interval of time; are as easily read as when made lengthways; while signals are, moreover, more compact, and slip is economised.

With either this or the Burke instrument, messages, it is true, may be translated, but it must not be forgotten that the signals are translated into the second cable with all the imperfections and weak contacts as received from the first circuit, so that when the cables are long, a better method of translating would be by "human relay," *i.e.*, either manual re-transmission by key, or (as this would require special training for the Burke system) by perforating another tape, at the intermediate station, to re-transmit with by automatic means. This would, in fact, be necessary when translating from a short into a long cable, unless the speed of the shorter circuit be reduced to that suitable for the longer one, which would waste the time which a higher speed would secure for local traffic through the shorter cable.

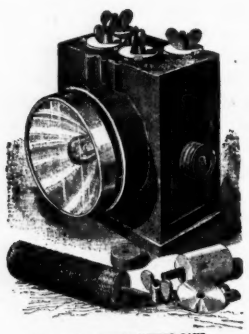
If the *single current* system and the ordinary dot and dash Morse signals must be retained to conform to the American method of working, then a relay on the Allan-Brown principle, *i.e.*, with a "movable zero," would accelerate speed, and be equally applicable to the Burke system of signalling.

In an article published in the Electrical Review of April last, Mr. Raymond-Barker gives the number of *elements* per average letter—including spaces—as 7·157 for the siphon recorder or mirror, and 9·123 elements for the Morse dot and dash system. When the additional signal for every letter, which the Burke system requires, is taken into account, the difference becomes as 7·1 to 10·1, so that it will be clear that the mirror or siphon recorder code generally employed for working long cables is capable of giving a much higher speed *irrespective* of the greater sensibility which these instruments possess, and the important consideration that their signals may to a great extent be protected from the disturbing influence of earth currents by signalling condensers.

AN EFFICIENT ELECTRIC BICYCLE LAMP.

The illustration represents a convenient, highly serviceable electric lamp for bicycles, adapted to burn for six or eight hours, which is being introduced by W. Pollock, of No. 565 Boulevard, New York City. It has two made up positive elements and two negative zinc elements, connected in series, the elements being inserted in sockets in the top of the lamp, and each held in place by a cap and screw nut, a rubber washer being placed on top of each. These appliances are also shown in the illustration, which we have reproduced from the *Scientific American*. The liquid charge is preferably made of water and sulphuric acid, of which a measured

quantity is supplied through the sockets provided for the positive elements. The zinc element is only about half the length of the positive element, and is thus held out of contact with the liquid when the lamp is in the position shown, the light being then extinguished, but the circuit is completed and the light established when the lamp is turned the other side up. The positive elements are furnished ready for use, wrapped up so as to take hardly the space of a small pocket knife each, and in riding it is generally best for one to carry an extra bulb and a pair of these elements. The new bulb is readily screwed in place in case one burns out or is damaged, and a new positive element is as readily inserted.



THE BELL ELECTRIC BICYCLE LAMP.

It is said the cost of using these lamps constantly is only 11 cents a week. The rider need not carry any acid with him, other than that in the lamp, the renewal of a light, should it go out, being effected simply by inserting another new element. There is absolutely no local action and the lamp may be used any time within a year after charging. The lamp is readily fastened in place by a swivel clamp at the back, not shown. In addition to its use on bicycles the lamp is adapted for carriages, mining purposes, country residences, and stables, night watchmen and policemen, &c.

A NEW BASIS OF DYNAMO CALCULATION AND CLASSIFICATION.

The *American Electrical Review* for June 16th, 1897, contains a paper by Prof. Carus-Wilson on a new basis of dynamo calculation and classification which is worthy of notice. The method consists of the introduction of a new factor of calculation called by the author the *induction factor*.

Consider a dynamo having C conductors on the surface of the armature, and let the number of lines of force per pole be N, and let there p pairs of poles connected in series. Then if there are i amperes passing through the dynamo, the torque in inch-pounds on the armature is given by

$$t = 1{\cdot}41\, p\, \mathrm{C}\, \mathrm{N}\, i\, 10^{-8} \qquad (1)$$

If N is constant this can be written

$$t = 1{\cdot}41\, \mathrm{M}\, i \qquad (2)$$

where M is constant for a given dynamo and depends upon the number of conductors on the surface of the armature, the flux per pole, and the number of pairs of poles connected in series, so that

$$\mathrm{M} = p\, \mathrm{C}\, \mathrm{N}\, 10^{-8}. \qquad (3)$$

If the armature has a constant speed of n revolutions per second, the E.M.F. generated is

$$e = p\, \mathrm{C}\, \mathrm{N}\, n\, 10^{-8}. \qquad (4)$$

From equations (3) and (4) we get

$$\mathrm{M} = \frac{e}{n}. \qquad (5)$$

Thus M is the E.M.F. in volts divided by the speed in revolutions per second, and is called the *induction factor* of the dynamo.

Multiplying equation (5) by i, we get

$$i\, \mathrm{M} = \frac{e\, i}{n},$$

that is i M is equal to the work done per revolution of the machine at any speed. If, therefore, i and M are given, the output of the dynamo can be calculated by multiplying the product, i M, by the number of revolutions per second.

Let T be the force at the rim of a pulley of diameter d centimetres, then

$$2\, t = d\, \mathrm{T}$$

and equation (2) takes the form

$$\mathrm{T} = \frac{1}{\pi\, d}\, \mathrm{M}\, i\, 10^{7} \text{ dynes.}$$

If now $\pi\, d = 10^{7}$ centimetres, we get

$$\mathrm{T} = \mathrm{M}\, i \text{ dynes.} \qquad (6)$$

The product, M i, is called the *force factor* of the dynamo, and is a force of M i dynes at the rim of a pulley 10^{7} centimetres in circumference.

The induction factor is of great use in working out the calculations in many problems of design. To illustrate, we take two examples from Prof. Carus-Wilson's paper.

Example 1.—Suppose that it is required to design a motor that will draw a car at 13 miles an hour with a tractive effort of 680 pounds on 33-inch wheels, with gear ratio 4·78 on a 500 volt line, the resistance of the motor being 1·3 ohms.

If the mechanical efficiency is to be 85 per cent., the total tractive effort, T, must be 800 pounds.

If E is the tension of the line, d the wheel diameter, v the gear ratio, S the speed in miles per hour, R the resistance of the motor, the induction factor is given by the following equation:—

$$\mathrm{M} = \frac{\mathrm{E}\, d}{11{\cdot}2\, v\, \mathrm{S}} \left\{ 1 + \sqrt{1 - \frac{8\, \mathrm{R}\, \mathrm{T}\, \mathrm{S}}{\mathrm{E}^2}} \right\} \qquad (7)$$

Inserting the given values in this equation, we find

$$\mathrm{M} = \frac{500 \times 33}{11{\cdot}2 \times 4{\cdot}78 \times 13} \left\{ 1 + \sqrt{1 - \frac{8 \times 1{\cdot}3 \times 800 \times 13}{500 \times 500}} \right\}$$

$$= 41{\cdot}7.$$

We see also, from the equation

$$\mathrm{T}\, d = 2{\cdot}82\, v\, \mathrm{M}\, i \qquad (8)$$

that the current when running with the given load would be 47 amperes.

The force factor, which is the product M i, must, therefore, be 1,960 dynes.

The induction factor may be made up in any way that is most convenient. If there are 720 conductors on the armature and four poles, the armature being series-connected, giving $p = 2$, we see from equation (3) that we must have $2{\cdot}89 \times 10^{6}$ lines per pole. Further, if the motor is series-wound, it must have the specified induction factor for 47 amperes in the field winding.

Equation (7) may be written in the form

$$\mathrm{M} = \frac{\mathrm{E}\, d}{7{\cdot}95\, v\, s} \left\{ 1 + \sqrt{1 - \frac{\mathrm{R}\, \mathrm{T}\, s}{18\, \mathrm{E}^2}} \right\} \qquad (9)$$

where s is the velocity measured in feet per second, and d is the diameter of the rope drum of a crane or elevator.

The current required for any given acceleration is given by the equation

$$a = 405 \times 10^{-4} \times \frac{v\, \mathrm{M}}{d\, \mathrm{W}} \times i_a. \qquad (10)$$

where i_a is the current required (over and above the frictional or running current) to produce an acceleration of a foot per second in a mass of W tons.

Example 2.—A train and locomotive weigh 780 tons, and have to mount a gradient of 0·8 per cent. at 10·7 miles per hour. The frictional resistance of the track is nine pounds per ton, reckoning at this rate both train and locomotive. The tension of the line is 625 volts. Four gearless motors are used, permanently connected in series, each having an internal resistance of 0·029 ohms.

Each motor has thus to move 195 tons on a tension of 156·2 volts. The draw-bar pull per motor for the gradient is 3,490 lbs.; for friction, 1,755 lbs.; allowing 95 per cent. mechanical efficiency, we get 5,500 lbs. as the required tractive effort per motor; inserting this value together with those for E, R, and S, in equation (7) we find the value of $\frac{\mathrm{M}}{d}$ to be 2·32, the value of v now being unity.

It appears that whatever size of driving wheel we employ, the induction factor must be 2·32 times the diameter; and

that so long as this ratio is maintained, the locomotive will haul the train up the gradient at the required rate. For instance, if we take wheels four feet in diameter the induction factor must be 111.

The current at full speed is 850 amperes from equation (8), and is unaltered by increasing or decreasing the ratio of M to d so that we should take d as small as possible, consistent with leaving a clearance for the motor and its attachments. The actual values of M and d for the motors in use on the Baltimore line are M = 144, d = 62 inches.

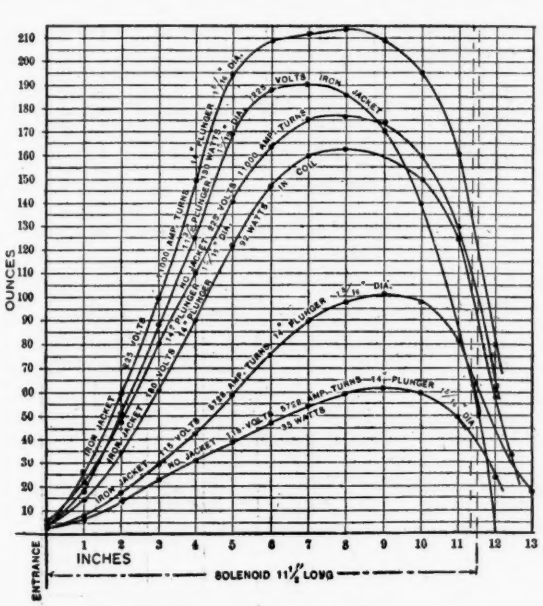
When running at full speed each of these motors would be doing work at the rate of 158 horse-power, so that the horse-power of the locomotive would be 632. The current from the line would be 850 amperes, as obtained from equation (8). This current will not, however, start the train on the gradient. We have to find then how much current is required to do this.

If the start is to be effected in 40 seconds, since the final speed is 10·7 miles an hour, or 15·7 feet per second, the acceleration must be 0·393 foot per second. Inserting this value in equation (10), remembering that W is 195, and $\frac{M}{d}$ is 2·32, we find the current required for acceleration to be 810 amperes, making a total current at the start of 1,660 amperes, or a force factor of 239 kilodynes. This agrees with the results obtained in starting a train of the given weight under the given conditions.

ACTION OF SOLENOIDS ON CORES.*

By W. H. CHAPMAN.

The proper proportioning of the solenoids used in the Chapman voltage regulators manufactured by the Belknap Motor Company has necessitated a set of careful experiments, the results of which have been plotted in curves for convenient reference. Some of these curves are of considerable



general interest as they show at a glance the effects of a magnetic return circuit, or, in other words, of an iron jacket and also the laws of increase of the force with the increase of the ampere turns.

The accompanying curves were taken from a simple solenoid 11½ inches long. The ordinates represent the ounces of force exerted on the plunger, and the abscissæ represent the distance that the end of the plunger has entered the coil at each observation. The various conditions under which the different curves were taken are designated on the curves themselves. Two different plungers were used as indicated; one of them was 14 inches long by $1\frac{5}{16}$th inches diameter, and the other one was $11\frac{3}{8}$ inches long by $1\frac{5}{16}$th inches diameter.

* New York *Electrical Engineer*.

INDUCTION IN SHORT SOFT IRON MAGNETS.

By H. O. EURICH, Stud. Inst.C.E.

Experiments were conducted by the author in the course of last year (1895-96) in the Electrical Laboratory of the Yorkshire College, Leeds, with the object of obtaining some information and data concerning the induction and distribution of induction in short soft iron bar electro-magnets. The following is a short summary of the results obtained.

The Ballistic method was adopted.

The six magnets experimented on had cores of Low Moor wrought-iron, their lengths being exact multiples of their diameters, and the diameter of the core was the same in each case. The cores as well as a test piece were cut from one rod. The coils exciting the cores were of the same lengths as the cores, and were wound to the same depths with No. 24 double silk-covered copper wire. They were first wound on formers and afterwards withdrawn. The external diameter of each was 1¼ inches, the internal diameter being ½ inch, and the diameter of the core $\frac{7}{16}$ inch. The space between the coil and the core was occupied by a thin split brass tube which carried the exploring coil. This tube was capable of being moved to any position on the core, at the same time keeping the core, the exploring coil, and the exciting coil concentric. Two of these exploring coils, of 5 and 9 turns of No. 36 Cu wire respectively, were used for the larger and smaller magnets.

Table I. gives the data for the magnets.

Table I.

	A	B	C	D	E	F
Length in diameters ...	1	2	4	8	12	16
„ of core in inches	$\frac{7}{16}$	$\frac{7}{8}$	$1\frac{3}{4}$	$3\frac{1}{2}$	$5\frac{1}{4}$	7
„ „ „ cms. ...	1·11	2·22	4·44	8·89	13·33	17·78
Total number of turns ...	131	273	582	1,225	1,595	2,382

Fig. 1 shows the connections, the full lines indicating the primary, and the dotted lines the secondary circuit.

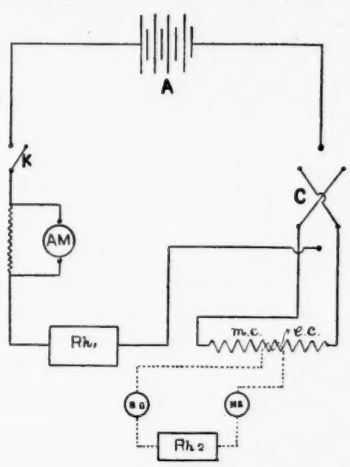


Fig. 1.

The following is an explanation of the letters in the figure:—

Primary Circuit.

A = 6 Epstein, and 6 E.P.S. accumulators.
C = a Pohl's commutator.
Am. = ammeter, being a shunted Weston low reading voltmeter, standardised by a Crompton potentiometer.
Rh_1 = a rheostat.
m.c. = the exciting coil.
k = key.

Secondary Circuit.

B.G. = a Nalder Ballistic D'Arsonval galvanometer, with damping key.
M.S. = Hibbert's magnetic standard.
Rh_2 = a rheostat.
e.c. = the exploring coil.

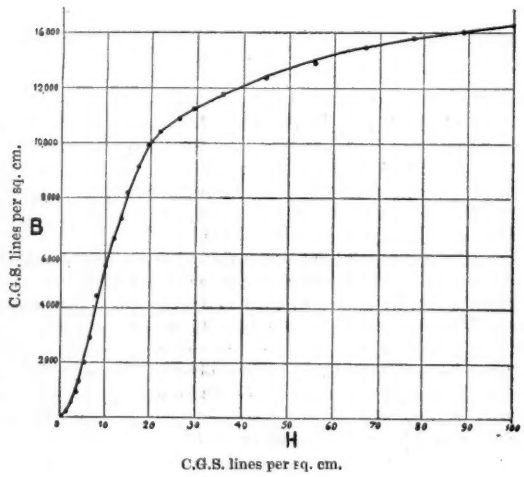


FIG. 2.

Fig. 2 shows the B H curve of the iron used, as obtained by Hopkinson's method. A determination made by the permeameter gave practically the same curve.

Method of Experimenting.

The exploring coil was placed in five different positions on the various magnets. In each position the current in the magnetising coil was increased in steps, and at each step the current was reversed four times, and a mean of the four corresponding readings of the Ballistic galvanometer taken. For each position of the exploring coil also the throw due to the standard magnetic field was taken and the induction easily deduced.

The resistance of the secondary circuit was varied so as to permit of considerable deflections with the smaller inductions, but in each position of the exploring coil it was kept constant, while the induction and magnetic Standard readings were being taken, so that no correction was required for the alteration of the damping effect on the galvanometer. The magnetic standard was checked throughout the experiments.

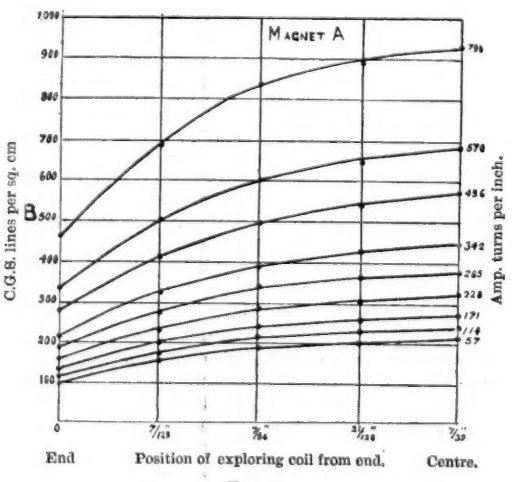


FIG. 3.

The five positions of the exploring coil on each magnet were:—(*a*) the middle, (*e*) the end, and (*b*, *c*, *d*) three equally spaced intermediate points.

Results of the Experiments.

Figs. 3 to 8 give some of the results obtained.

Figs. 3 and 4 are curves showing the distribution of magnetism for different ampere turns per inch in the magnets A and F.

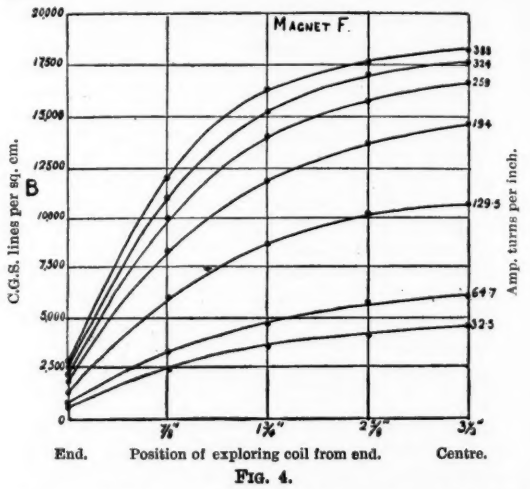


FIG. 4.

Figs. 5 and 6 show the relation between the induction at the centre in C.G.S. lines per square cm., and the ampere-turns per inch for the six magnets.

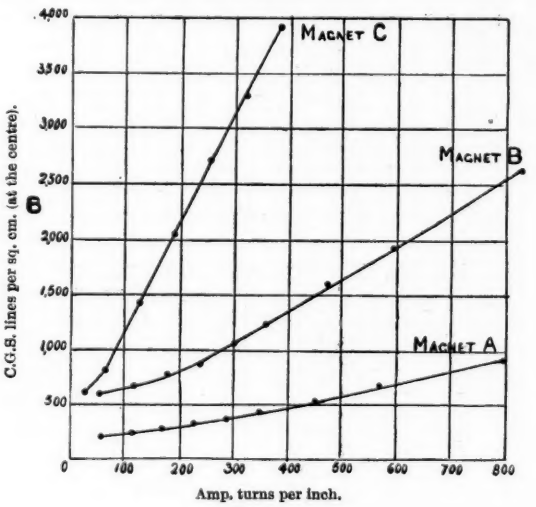


FIG. 5.

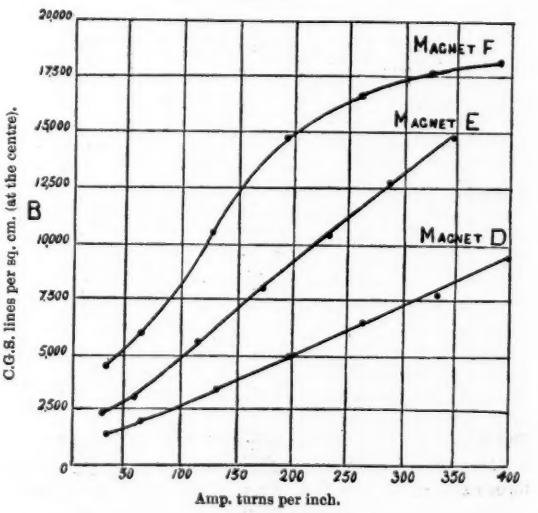


FIG. 6.

Figs. 7 and 8 show the ratio of the induction at any point along the magnet to the induction at the centre for different ampere-turns per inch.

In fig. 7 the magnets, A, B and C, are shown; in each magnet the induction at the centre is taken as unity for both the highest and lowest ampere-turns per inch, in order to compare the rate of decrease of induction.

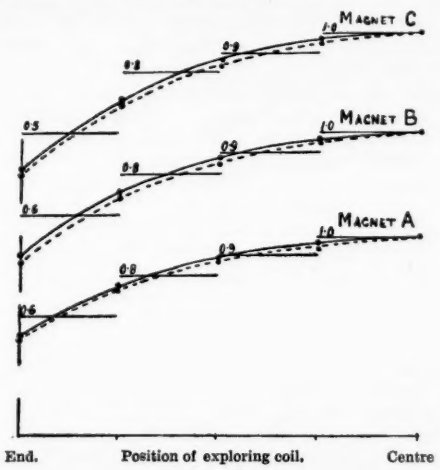


FIG. 7.

In fig. 8 there are three curves for each magnet, comparing the induction for the highest, middle, and lowest values of ampere-turns per inch.

In the figures, the full lines denote the highest values, the chain lines the middle, and the dotted lines the lowest values of Si per inch.

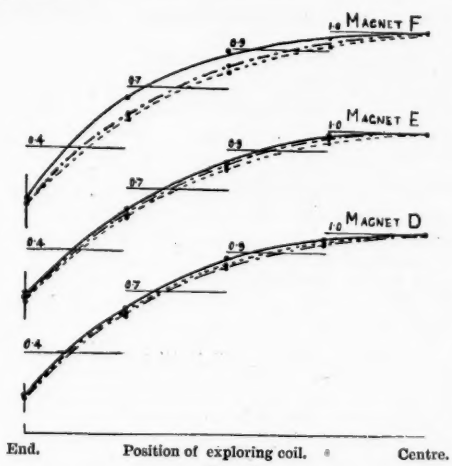


FIG. 8.

Tables II. and III. give the values of the Si per inch, with the corresponding induction at the centre.

TABLE II.

	B	Si per inch.
Magnet A	213	57
	933	798
Magnet B	596	59·3
	2,645	830
Magnet C	604	31·6
	3,930	380

TABLE III.

	B	Si per inch.
Magnet D	1,455	33·3
	5,000	200
	9,510	399
Magnet E	2,345	28·9
	8,080	173
	14,870	347
Magnet F	4,530	32·5
	14,800	194
	18,330	388

In conclusion, the author begs to acknowledge his indebtedness to Mr. J. D. Cormack, now of the University, Glasgow, for his kindly interest and aid in the preparation and execution of his experiments.

STEAMING CONDITIONS IN ENGINES AND BOILERS.

[COMMUNICATED.]

It has always been customary to set great store by the amount of savings that can be made in the engine department with special details, like governors, valves, jacketing of cylinders, because a close approximation to actual value may be taken of any of them. They show themselves either by diagram calculations, regularity of revolutions, or some equally direct measure. There being something definite to work upon as a basis, much is made of it accordingly, and a ready adoption of novelties, which secure certain results, has generally followed. This is not to be wondered at, because those interested have had graphic representations put before them of advantages which do not admit of much dispute. The engine has therefore claimed attention, while the boiler, viewed rather in the light of the necessary drudge than the fine steed, has been often passed over. Corliss gearing lends itself immediately as an example of this. To look for an excuts off the admission of steam, and opens to the exhaust, with a quickness and expenditure of power unobtainable perhaps with any other form of valves. The indicator cards given off from it are the admiration of all engineers, and however complex and intricate such gear may seem to those unfamiliar with it, there is an underlying principle which is of the greatest importance, and of the most beautiful simplicity. Whatever the actual value of such mechanism may be, expansions of steam to any degree demanded may be made without wire-drawing, and the adiabatic curve is usually a very even line. This case is therefore one of those where inventive faculty furnishes results capable of ocular demonstration. One has only to see such an application to immediately recognise merits in it. Does this success, however, prove with others there may be like it, that the engine using the steam which the boiler generates claims all our spare energies, and there is no necessity to study how the quiet worker next door fares? If so, it means that in addition to such an instance as we have quoted, we have only to take into account the sensibility of the governing arrangements, the amount of bearing surface provided, efficiency of piston packings, lubrication, and if by various methods these details show themselves to be in good order, we need have no concern as to how the boiler is serving us. But, however useful and necessary it is to watch closely the engine parts, for if they are not properly attended to they may be the occasion of great losses, either by leakage, excessive friction, or condensation, yet we are stepping into the domain of the maker or the engineer responsible for the original purchase, because if not designed properly at the outset, there is not much chance afterwards of any great amendment. However we may derive satisfaction from an engine that works quietly without knock or noise of any kind, and feel we are getting the most out of it that is possible, if such a high standard is not attainable, those in charge are generally powerless, because mistakes in construction cannot be afterwards modified. True, we can usually find out what is wrong, but too often the engine may be said to have the defects of its qualities, and though we may know the faults we are not in the position of being able to remedy them.

Great fascination is experienced, however, in endeavouring to find out errors of omission and commission, and the fewer there are the greater is the credit to the maker. As a lengthened period is required for some of these errors to develop themselves, the process of watchful care goes on continually. The engine favours this solicitude, as it is in the nature of an exact science in almost every part. If we are not sure of making up for deficiencies, we are able to put our finger on the weak spots, and that sufficiently or accurately enough to leave not much room for doubt as to their locality. We can trace the steam as it leaves the boiler and account for it in its passage through the pipes, valves, cylinders, and so on to the condenser. The effects of excessive lengths and sizes of connections from engine, undue clearance, the correct setting of

valves, due proportioning of cylinders and receivers, are all well known and understood. A capable engineer therefore finds that his interest increases with the lessons every day brings forth. The motion itself is the cause of many of the demands upon him from the wear and tear produced thereby, adjustments have continually to be made to keep even an engine that runs well, up to its proper standard, and if from any ill design attention is constantly required, then very little opportunity is left for outside matters. These remarks generally apply where any high-class installation is fitted, whether it be for electric lighting, marine, pumping, or similar work, if the machine is to keep running at long stretches at a time and give the best torsional effect with least expenditure of steam.

Hence it can be well understood why the boiler often suffers for want of recognition. The conditions ruling with it are quite different. It cannot be set down in place just as it leaves the factory fully ready for working as the engine can. On land there are its brickwork casings and chimney to be put up, and these very often have a great deal to do with the economical question. The engine only requires erecting just as it was in the shop, but the boiler must be complete with its settings before it can be steamed, and this is where some of the otherwise good qualities of the generating apparatus may be quite nullified. The course of the flues, or the distance of the chimney from them, may not be correct, so that the height of the chimney does not have its full effect on the draught. The brickwork may not be of a character to prevent leakages, and keep the boiler what it should be, a good reservoir of heat ready for all demands of the engine upon it. On the other hand, when once started there are no risks of breakdown. There are no parts which, by reason of their motion, have a tendency to get out of order or come to a sudden stop. Thus the steady going servant is left pretty much to take care of itself, and mountings have to be of a kind requiring no attention of any sort, or they will certainly get into disuse. In a word, they must be automatic in their action, or duplicated. Valves are arranged so that, if one should stick, there is a second on which to rely, gauge glasses to avoid giving false indications, fusible plugs for emergencies in case of low water. These, and other contrivances, are made to meet every possible contingency from want of oversight, and that such few accidents happen proves they come up to expectations. Taking a boiler plant as a whole, unlike the engine as it is in every respect, details of improvement may be applied at any time. The engine is constructed, and no fault in principle admits of amelioration afterwards. We can but attend to trifles, but with the boiler, though the structure itself cannot be modified much, we find there are several fittings which may be applied both to the boiler and also to the flues at any period; therefore, though an engineer must of necessity never leave his engine, it is much more likely to repay him to give what spare time he has to the source of his power. Varying according to the class of engine, there should be an efficient water heater fixed, and no impurity allowed to obtain admittance, to afterwards require removal in the way of sediment. If the form of the boiler is in any way detrimental, aids to circulation are required so that there is no stagnant water anywhere. Dry steam is such a desideratum that any good means for its provision is always sure to be of advantage. Prominence has been given in recent years to heating the air before it reaches the fires, and to exhausting to a minimum what remains in the gases from the flues. There is a certain prejudice against mechanical firing and grate fittings, but there can be no question as to the economical results obtained from them, and that is why this class of apparatus has made its way in recent years. The same is the case as regards forced draught for getting large powers on emergency or burning inferior coal. The whole subject of economical firing and smoke consumption is but imperfectly understood, but if instead of the old standard of coal in terms of water evaporated, the cost of the steam were taken in money value, then the interest on the relative prices of the different apparatuses would receive their proper measure. What may be very good when tested on coal saving alone, would not come out always so well if the amount paid for it, and any after repairs, were strictly considered. Again, if great care is not taken, the adoption of an otherwise important improvement may lessen the advantage of something equally good already in use before. There is no settled consensus of opinion possible on this matter, because no two sets of conditions are alike. Not only do the different types of boilers require to be looked at from different standpoints, but even two exactly similar ones may be perfectly at variance in their steaming powers by reason of the surroundings with which each is erected in place.

A boilermaker can well plead that his responsibility finishes with test on delivery, but this can never be so with the engine maker, and it is customary to retain a portion of the purchase money for a time to ensure due performance of the contract entered into. This is not too much to ask, because though an engine may appear in every respect satisfactory in the shop, when it comes to steady daily running, if there are any flaws in manufacture they are certain to be discovered. With the boiler itself, however, the double water pressure to which it is subjected represents sufficiently all the strains it will have to undergo under steam. To what extent the difference in the conditions pertaining to the two component parts of a steam plant may have had to do with the general separation of the trades from each other it is not our present province to enter into, but where an engine maker formerly produced his own boilers he now finds it more profitable to buy from regular factories turning out only the one class of work. There is no risk run, because boilers seldom fail to come up to the standard expected from them, but where the engineer can rest satisfied in purchasing a boiler it would not be possible for a boiler maker to do the same with an engine. The latter, therefore, starts its life with an importance that is denied to its fellow, and this continues throughout its existence. We have endeavoured to show, however, that the boiler should not be despised because it does not start with the lead but rather that it admits of improvements after location that are well worthy the attention of all engineers in charge who have economy in view.

CORRESPONDENCE.

A Strange Magnetic Freak.

Although your correspondent "A. R. U." has made his interesting magnetic ovservations on "several hundred" table knives at "widely separated places," it would appear that he has omitted to investigate the properties of the table knives of the southern hemisphere.

If he will extend his observations to any iron lamp-post he may chance to come across, he will find that it exhibits the same "magnetic freak;" that is to say, the end which is habitually pointing downwards (*i.e.*, which is buried in the ground) is invariably a north pole. This, however, is not strange, when it is remembered that, in our part of the world, a magnetic needle "dips" its north end downwards.

The normal position of a table knife when in use is with the end of the blade downwards. Even in places where it is used for conveying food to the mouth (which "A. R. U." may or may not have included in his investigations) the mechanical shocks which it is subjected to, are probably of greater magnitude when the point comes in contact with the plate than when the position is reversed.

Again, when washing table knives, "which are fixed in handles," a careful and dutiful servant will invariably place them *point downwards* in hot water in order that the handles may not get wet; and this treatment—though he (or she) may not know it—will undoubtedly tend to maintain or strengthen the flux of magnetic induction through the blade.

A. S.

July 30th, 1897.

Commutator Bars.

Mr. Haswell's note to me on p. 149 of to-day's Electrical Review is not a reply to my question on p. 113. I did not question how to perform a simple calculation, but disputed Messrs. Bolton's statement to me that their "List of Stock Sizes of Commutator Bars" is satisfactory to their customers. If they would solve the equation on p. 149 for each stock size and then put the results in their "List," it would make it as satisfactory as the bars they supply. They would omit those sizes which give a fractional "number of sections."

For the dynamo designer's purpose, the equation I gave is the quickest way to select a "stock size" for a given design,

$$t_1 - t_2 = 2\ w \tan \tfrac{1}{2}\ \text{A}.$$

The value of the second member can be calculated taking w and A from the drawing. Then only those stock sizes whose $t_1 - t_2$ (from the "List") equals that value need be considered. Of course w (radial depth of copper) may be altered somewhat to suit a stock size.

Theodore Stevens.

Mundesley, *July 30th*, 1897.

Electric Pumping Plant.

Mr. E. Kilburn Scott's description of the asynchronous motor pumping plant at Portsmouth in your issue of July 16th is interesting, but the figures relating to the output of the motor are, at any rate to a casual reader, startling.

If one is to understand that it is only possible to obtain 2·5 H.P. from a motor rated at 6 H.P., and presumably absorbing that amount of energy from the mains, the efficiency of this piece of machinery is evidently not of a very high order. When it is remembered, however, that the efficiency of a centrifugal pump is seldom more than 50 per cent., the case against the motor is not so bad as Mr. Scott would make out. Having had something to do with these motors and their switching gear, I fail to see that any "specially skilled attention" is required; indeed, from the attendant's point of view, the asynchronous alternating motor is to be preferred to the continuous current type with its brushes and commutator.

Further, the statement that "by no manner of means can the gear be made automatic," is rather sweeping, though in certain cases it might present some difficulties.

The paragraph relating to the saving of copper in the mains being swallowed up in the transformer winding is also, I think, misleading, as it is hardly to be expected that a 20-kilowatt transformer is required for a 6 H.P. motor, asynchronous or otherwise. Moreover, if the saving in copper is overbalanced by the cost of transformers, wherein lies the virtue of high tension distribution, either by continuous or alternating currents?

Geo. Broughall.

Altrincham Electric Supply, Limited,
August 4th, 1897.

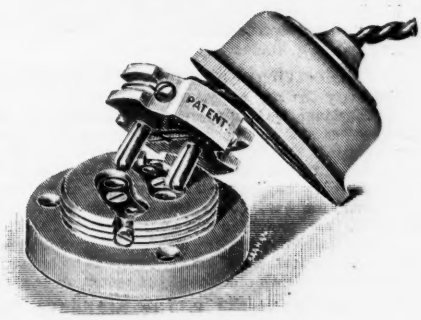
BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Aug. 4th, 1896.	£	s.
Alexandria	700	0
Amsterdam	11	0
Antwerp	38	0
Bombay	10	0
Boulogne	15	0
Brussels	519	0
Calais. Five tons telegraph wire, no value declared.		
Cape Town	589	0
Colombo. Teleg. mat.	145	0
Durban	705	0
East London	246	0
Genoa. Elec. launch...	220	0
Gothenburg	63	0
Hong Kong. Teleg. mat.	1,530	0
Melbourne	309	0
" Teleg. mat.	325	0
Nagasaki	32	0
Ostend	83	0
Passages	45	0
Penang. Teleg. mat. ...	331	0
Perim	28	0
Port Elizabeth	197	0
Shanghai	1,247	0
Singapore	180	0
Stockholm	195	0
Sydney	858	0
Wellington	67	0
Total	£8,688	0

Week Ending Aug. 4th, 1897.	£	s.
Alexandria	26	0
" Teleg. mat.	85	0
Amsterdam	50	0
Antwerp	106	0
Bombay	28	0
Calcutta	22	0
Cape Town	26	0
Durban	120	0
East London	162	0
Gibraltar	50	0
Hamburg	33	0
Melbourne	13	0
Odessa	1,000	0
Rotterdam. Teleg. wire	284	0
Rouen	12	0
St. Lucia. Teleg. wire	22	0
Total	£1,839	0

Ceiling Roses.—We have received from Mr. A. P. Lundberg a sample of a detachable ceiling rose designed for high voltage requirements, which is claimed to possess some novel features and to be very compact and containing provision for taking strain off the terminals. The rose possesses a good length of fuse, which is in such a position that in "blowing" no harm can be done. All the brass parts are well protected, so that accidental short circuit or leakage of current is prevented. The detachable portion is made by two springy brass pins in a similar manner to that adopted in wall connections. The renewal of a fuse is claimed to be a very simple operation, and can be done right away from the fixed part of the ceiling rose. Those who have attempted to renew fuses in a ceiling



rose when at the top of a ladder will appreciate this advantage. The ceiling rose will be found useful while the wiring of a building is in progress, as the brass part need only be fixed to the ceiling and connected, the cover and detachable portion being added afterwards. When redecoration of a room becomes necessary, the cover, detachable portion, flexible, &c., can be detached and removed right out of the way of workmen. As "Universal" wall plugs interchange with them, the brass of this ceiling rose can be conveniently used as a temporary wall socket.

Change of Address.—Messrs. Claud Hamilton, Limited, have removed from Waterloo Street to 247, St. Vincent Street, Glasgow.

Compressed Air.—The Clayton Air Compressor Works, of New York, has issued a very complete catalogue of air compressors. Clayton air compressors are described in great detail, and a mass of useful and interesting matter is given on this important subject. The book abounds in explanatory and general illustrations of the plant and apparatus described. It contains illustrations and lists of sizes of the standard patterns of compressors, and a descriptive article upon the widening use of compressed air, showing all the various applications of this power up to date. It also illustrates and explains the Clayton air lift and pumping system, which is achieving remarkable results in raising water from wells by means of compressed air. Among the other contents of this catalogue will be found valuable data for figuring the loss of pressure due to friction in transmitting compressed air through pipe, and the capacity lost by air compressors in operating at various altitudes above the sea level.

Electric Launches.—The Thames Valley Launch Company, of Weybridge, have, we understand, delivered 14 electric boats from their works since last September, two being for Chester, one for the Government, one for the Southport Corporation, one for Llangollen, and others to different places on the Thames, or elsewhere, for use on rivers, canals, lakes, &c.

Enclosed Arc Lamps.—Messrs. Beanland, Perkin & Co., of 20, Park Row, Leeds, have secured the exclusive rights for Great Britain and the Continent for the improved "Ajax enclosed globe arc lamp," and are now prepared to supply it. The lamp is understood to represent the fruit of three years' study of the problem. The "Ajax" lamps use a new and simplified form of rack feed in place of the clutch feed hitherto employed, have no loose joints or connections to be affected by jar or sparking, and will burn in any location without flicker or interruption. The lamp is only 30 inches in length, is ornamental in design, and is made in several different styles of finish for all uses. At present it is furnished for direct current only, and can be used either singly on 90 to 110 volts, or in series up to 1,000 volts, in which case the lamps are provided with automatic cut-outs and external resistances. Lamps for alternating current will soon be ready. The lamp is said to be fully protected by detail patents already taken out or applied for. The patent light-diffusing Holophane inner globes or bulbs can be successfully used in this lamp, by which, it is said, a gain of 50 per cent. in the effective light is secured, with better distribution. This gain in effective light, coupled with the excellence of the feed, is claimed to render the lamp peculiarly adapted for street lighting or the illumination of large open spaces.

Gas.—At Ferry Street, Dudley, leakage of gas led to an explosion and fire on 27th ult.

High Speed Engines.—A very fine pamphlet has been issued by Messrs. Alley & MacLellan, of Glasgow, describing in great detail, and with the aid of numerous excellent illustrations, the Westinghouse type of high speed engines, simple and compound, as

manufactured by the firm at the Sentinel Works. We have not space to spare to refer to the pamphlet at such length as it deserves, but an idea of the ground covered will be gained from the titles of the various sections, which are:—General description; principles of steam economy; repair system; the peculiar advantages; cautions; simple condensing engines; Westinghouse type compound engines; automatic *v.* throttling governing. There are some good photographs of semi-portable plants, condensing plants, patent method of belt driving, Westinghouse engine direct coupled to Sayers's dynamo and several other direct driven plants. Our readers will find this a very interesting pamphlet. The slip-shod manner in which some catalogues and price lists are brought out often inclines those who receive them to cast them aside, but this cannot be said of the present pamphlet issued by Messrs. Alley & MacLellan, which, on account of its excellent get-up, and the value of the descriptive matter as well, is worth keeping for future reference.

The Brush Electrical Engineering Company, Limited.—In the Chancery Division on Saturday, before Mr. Justice Stirling, Mr. Graham Hastings, Q.C., appeared in support of a petition for the reduction of capital of the Brush Electrical Engineering Company from £750,000 to £660,000. The company had issued 90,000 preference shares of £2 each and 90,000 ordinary shares of £3 each, all being paid up, or credited as paid up, in full. The ground of the present reduction was, that capital had been lost to the extent of £90,000, or was unrepresented by available assets, and it was proposed to effect the reduction by making the nominal value of the ordinary shares £2 instead of £3. There was no opposition to the petition, and his Lordship sanctioned the reduction as asked.

The City of Montreal v. the Standard Light and Power Company.—This case was before the Judicial Committee of the Privy Council on 28th ult., there being present Lord Macnaghten, Lord Morris, Sir Richard Couch, and Sir Henry Strong. This was an appeal from a judgment of the Court of Queen's Bench for Lower Canada of October 3rd, 1896, affirming a decision of the Supreme Court of Quebec. The suit had reference, says the *Times*, to the right of the respondent company to lay underground wires in the city of Montreal. The company alleged that by an Act of the Provincial Legislature they were empowered, amongst other things, to lay their wires and pipes underground for the purpose of supplying electricity and gas for light, power, and heating, subject to certain regulations, and that, having failed to obtain from the municipality of Montreal any directions as to the manner of opening the streets in that city, they commenced the works at large expense and labour. The city, as they asserted, interfered with their operations and used force to drive their servants from the streets, thus occasioning much loss and damage, besides involving the company in very heavy expense. The municipality, on the other hand, alleged that the property in the streets of Montreal being vested in them, the respondents were not entitled to break up or interfere with those streets without their consent, and they were justified in preventing the respondents from making the excavations and laying down the underground wires and pipes. The Courts below decided in favour of the respondents. At the close of the arguments for the appellants, Lord Macnaghten intimated that if their Lordships desired to call upon the learned counsel for the respondents they would be summoned on another occasion. Otherwise their Lordships would take time to consider their judgment.

ELECTRIC LIGHTING NOTES.

Ashton-under-Lyne.—The proposal of the Town Council to raise a £34,500 loan for electric lighting was the subject of a Local Government Board inquiry a few days ago.

Aston.—The Council has instructed the Highways and Building Committee to consider the desirability of applying for a provisional electric lighting order, and to obtain such expert assistance as is necessary for the purpose.

Belfast.—Among the applications for a supply of current for motive power and lighting purposes, are the proprietors of the *Ulster Echo*. As already stated, the *Belfast Evening Telegraph* uses electric motors for printing purposes with considerable advantage.

The question of electrically lighting the Dufferin and Salisbury Docks districts, as well as the entrance from the Channel to Spenser Basin, is under the consideration of the Harbour Board.

Bermondsey.—The Electric Lighting Committee have prepared a report in favour of the Vestry undertaking the supply of electricity throughout the district, and the continuous current system at a pressure in all of about 450 volts is recommended for adoption. The site recommended for the generation station is a part of the Vestry depôt, and the total outlay is estimated at £15,635. The annual surplus after meeting all charges is estimated at £588. The report came before the Vestry last week, and consideration was adjourned until after the recess.

Cardiff.—The Property and Markets Committee last week approved certain alterations in the electric lighting of the market, with a view to effecting economies, as the lighting bill has increased considerably since the electric light was put on. One side of the market will be temporarily altered, and then the Committee will inspect it and go into the matter again. The alteration is stated to effect a reduction of £90 per annum. Last year's bill was £491 for electric light and £68 for gas.

Cheltenham.—A Local Government Board inquiry into the Council's application to raise a £4,765 loan for electric lighting extensions was held last week.

Chesterton (Staffs.).—The Parish Council will submit the £6,800 electric lighting scheme to a public meeting.

Croydon.—The Croydon Town Council have decided to take over the electric lighting works from March 24th next from the British Thomson-Houston Company, the first year of working terminating on the date named, and the Council, by taking the works over, will have to pay a penalty of £1,000; but it is calculated that after paying this sum, the Corporation will still have a profit of £1,600.

Durham.—The Asylum Visiting Committee decided to adopt the electric light in the Winterton Building and the church. The gasworks are now inadequate for the whole lighting of the asylum, and to bring them up to date an expenditure of £2,000 would be necessary. They were still capable of doing the work for the other portion, and they now proposed to spend £2,587 on electrical plant for illuminating the parts mentioned. The medical officers, considering the present crowded state of the institution, were of opinion that the electric light would be decidedly preferable to gas. The Durham County Council approved of the report.

Edinburgh.—The proposal to light Portobello electrically, the installation costing £13,500, was brought up at the Town Council's meeting last week, and consideration of the subject was deferred until the next meeting.

Electric Lighting Bills.—In the House of Commons last week Mr. T. M. Healy asked the President of the Board of Trade whether his attention had been called to the great waste, expense, and trouble caused by the annual repetition in provisional orders dealing with electric lighting, of common form clauses; whether he would consider the desirability of bringing in a public Bill containing model clauses dealing with electricity, on the principle of the Gas and Land Clauses Acts; and if his department would endeavour to keep Irish provisional orders by themselves instead of incorporating them in English and Scotch Acts. Mr. Ritchie replied that his attention had been called to this subject, and whenever an opportunity occurred he would introduce a clauses consolidation measure of the kind mentioned. As far as possible provisional orders dealing with electric lighting in Ireland would be grouped in separate Bills.

Ealing.—The Electric Lighting Committee report there are 10,965 private electric lamps in use. Several large orders are under consideration.

Factory Lighting.—The electric light has been installed at Mr. Drewett's Royal Carriage Factory at Northfield End, Henley. The installation includes a 3 H.P. gas engine, driving a dynamo by Webster, Michelson & Co., and 26 Epstein cells. The work was carried out by Mr. Heckman, of Henley.

Gorton.—A member of the District Council proposed last week that an electrical expert be engaged to report upon the cost of putting down an electric light for the district. The matter was deferred until the next meeting.

Hampstead.—The report of the Electric Light Committee covering the fifteen months from Christmas, 1895, to Lady Day, 1897, shows that in that period the capital expenditure has increased from £56,522 to £83,331. An overdraft of £22,771 is due to the bankers, and will be met by a new loan. Against this, however, the working profits for the fifteen months amounted to £5,257 12s., equivalent to 6·3 per cent. on the capital. The net profit, after paying off interest and a proportion of the principal of the loans and providing for a sinking fund, was £1,900. The private consumption of the electric light had increased at the rate of 334 per cent. in Hampstead during the fifteen months.

Hampstead.—The Electric Light Committee has instructed the architect of the new electric lighting buildings to prepare two estimates of the cost of replacing the wood floor in the present engine room, viz. (1) by iron joists, with tiles in concrete, and (2) by iron joists with wood blocks in concrete, and that they had instructed the engineer to dispose of the surplus (waste) oil from the engine room at the price of not less than 4d. per gallon.

Harbour Lighting.—The Bo'ness Harbour Commissioners have instructed Messrs. Thos. Meek & Son, the harbour engineers, to prepare a specification to obtain tenders for an installation of electric light for the harbour and docks.

Hornsey.—The District Council has resolved to apply for a provisional electric lighting order to prevent the monopoly getting into the hands of two companies who had given notice.

Hospital Lighting.—The Metropolitan Asylums Board has decided to obtain tenders for lighting by electricity according to Prof. Ayrton's specification the additional staff block at the North Western.

Hull.—Mr. T. B. Clothier (of the Stafford Corporation Electricity works) has been appointed assistant electrical engineer at the Hull works at £120 per annum.

Kingston-on-Thames.—A Local Government Board inquiry was held last Friday in respect of the Council's application to borrow £20,000 for the purpose of electric lighting works. The Town Clerk said that the application was necessary, in consequence of excess in the expenditure on the amount previously borrowed of £5,405, and the proposal of the Corporation to further extend the works, at an estimated expenditure of £14,000. The extension would allow another 6,000 8-candle lamps to be on at one time. There was no opposition.

Larne.—The Town Commissioners have accepted an amended tender of the Larne Electric Light Works, Limited, for lighting the town for three years from August 1st.

Leicester.—The total output of electric current from the electric lighting works for the half-year ended June 30th was 145,341 units, as against 95,958 units in the corresponding period of last year, an increase of 49,383 units. There were 286 consumers. The Council approved the report to this effect last week.

London.—According to the daily Press, a fire occurred in one of the electric light manholes in the pavement near King William Street, Strand, on Thursday last week. On the cover being removed the electric light culvert was found to be in flames. It is stated that "a faulty connection in one of the leads had generated a spark, which in turn set fire to the insulation."

Montrose.—The managers of the Royal Lunatic Asylum, Infirmary and Dispensary, have decided to light the large new house for private patients by electricity. The current will be obtained from the machinery at the main building of the institution, the wires being conveyed in a large duct to the new house. The cost is to be about £1,580.

Morley.—A Local Government Board inquiry was held at the Town Hall, Morley last week with respect to the application of the Corporation to the Local Government Board for sanction to borrow £19,500 for purposes of electric lighting.

Portsmouth.—Messrs. Ferranti have informed the Electric Lighting Committee that they are involved in the engineering strike, and cannot be certain of being able to deliver the machinery they are under contract to make within the stipulated time. Therefore they have brought the strike clause into operation.

Scotland.—A Stirling paper says that in consequence of the success of the electric lighting at Murthly Castle, Mr. Steuart, Fothringham House, Forfar, and Mr. Graeme Whitelaw, Strathallan Castle, are also introducing the electric light, water-power being obtained from the River Machany. Both of the installations are being carried out by Mr. R. F. Yorke.

Shoreditch.—Last Saturday afternoon a party of the London Reform Union visited the electric lighting and refuse destructor works at Pitfield Street. Mr. C. N. Russell, the electrical engineer, showed the party round.

Stourbridge.—The District Council have resolved to seek powers to light the town with electricity, but, says a correspondent, the purpose of the Council, as announced, is not to adopt the light but to keep competitors out, the Council being interested in the consumption of gas.

Tunbridge Wells.—The Tradesmen's Association have passed a resolution calling upon the Town Council to extend their system of public lighting by electricity. The chief complaint of the association is that the public lighting is sacrificed to the interests of the private consumer.

West Hartlepool.—Prof. Kennedy, who was called in to advise the Corporation on the electric lighting question, has just reported favourably of the scheme, which he estimates may be carried out for a capital outlay of about £30,000, with a possible profit on the first year's working of about £600.

Willesden.—The District Council has got one step further in regard to electric lighting. The Works' Committee has considered the reports of Messrs. Robson & Trentham, to which we have already referred, and they recommend that a special meeting of the Council be held, with a view to passing a resolution applying for a provisional order, a Sub-Committee being appointed to go generally into the subject of the application. The Council has adopted this recommendation.

Worcester.—A Local Government Board inquiry was held recently into the City Council's application for sanction to borrow £8,834 for electric lighting purposes. The Town Clerk said that the loan was rendered necessary by the increased demand for light, and Mr. Murray, the electrical engineer, stated that the demand last year had increased by 50 per cent. They were able, practically, to meet that last year by running the whole of the plant and leaving no reserve. At present they had capacity for supplying 15,000 lamps, and were asking for another 9,000, so as to bring the total up to rather more than 23,000, the number of lamps which they had already connected. Mr. Murray explained that they now had far more lamps connected with the mains than they could supply at one time. Explaining the need of a new 100 H.P. engine that was stated to be required, Mr. Murray said that they had some of their machinery driven by water, but they had never had sufficient water power to get the full power from that part of the plant, and the engine would assist the turbine. The amount still outstanding was stated to be £56,582. There had been £59,877 borrowed, and £3,295 had been paid into the loans fund.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Cork.—According to *Daily Tenders and Contracts*, the Cork Corporation have been notified that in connection with the electric tramway scheme contracts have been signed with Wm. Murphy for the construction of the permanent way, and with the British Thomson-Houston Company for the electrical portion of the work.

Dudley and Stourbridge.—An extraordinary general meeting of the tramway company was held last week for the purpose of considering the agreement for sale of the company's undertaking to the British Electric Traction Company, Limited. Mr. G. Bagott presided. The agreement showed that the amount agreed upon for the purchase of the concern was £44,208 15s., or £3 15s. per share, and a dividend of 3 per cent. up to the date of completion, December 31st next, conditionally that satisfactory arrangements could be made with the various local authorities for an extension of the company's lease, and, failing this arrangement being effected, for £2,000 to be paid to the company. In moving that the agreement be adopted, the chairman strongly advised the shareholders to accept the terms that had been arranged, believing that it was the best thing for them to do, seeing that local authorities were determined to have electric traction, and their lease only lasted for another five or six years. Mr. C. A. Edge seconded. Mr. Garcke said the reason of the purchase being conditional was because the company's lease was so short that they could not go to the expense of putting down an electric track without a further extension from the local authorities. The resolution was carried.

Leeds.—The Kirkstall and Roundhay electric tramways were formally opened on 29th ult., in the presence of a large company. Among those present were the Lord Mayor, Sir James Kitson, Bart.; the city engineer, (Mr. B. Hewson); the electrical engineer, (Mr. Burbidge); the highways surveyor, (Mr. T. A. Prince); the tramways manager, (Mr. Wharam); Dr. Hopkinson, (the consulting electrical engineer); Mr. Talbot (his assistant); Mr. Taylor (representing Laing, Wharton & Downe, of London); Mr. Hill (Greenwood and Batley); Mr. R. H. Fowler (Fowler & Co., Limited); Alderman Milling and Alderman Higginbottom, of Manchester; Mr. Talbot (electrician to the Nottingham Corporation).

Liverpool.—The report of the Special Committee of the City Council, which has been inquiring into the best means of improving the city tramway service, has been issued, and a copy is given in the *Liverpool Daily Post* for July 30th. Reports were also prepared by Mr. Graham Harris, of Messrs. Bramwell & Harris; Mr. F. S. Pearson, of New York, and Mr. G. C. Cunningham, of the Montreal tramways. We make the following extracts from the committee's report:—Where so important a problem has to be solved, as to the system of traction to be applied in Liverpool, involving an early outlay possibly exceeding one million sterling, it is satisfactory to find a unanimity of opinion that electricity has, without question, shown itself to be the best form of motive power yet devised for tramway purposes, and that as regards cost and efficiency, it has proved itself economical and reliable. Mr. Pearson, in his report, states that he estimates the cost of operation per car per mile as follows:—

	Cost of operation per car mile.	Cost of operation per year on the basis of 130,000 car miles per mile of track.
	d.	£
Overhead trolley	3·68	138,000
Slotted conduit	4·00	150,000
Compressed air	5·02	188,250

As compared with these figures, Sir David Radcliffe stated that on the same data the present cost of horse traction in Liverpool is 7·19d. per car mile, and the cost of operation per year £269,625. The reports generally agree in recommending the overhead wire and trolley system as being the cheapest and most satisfactory mode of transmitting the electricity to the cars. The objection hitherto offered to this plan has been the unsightliness of a system of overhead wires in the streets of the city. Electricity can be conveyed by the conduit system, which is a channel constructed below the level of the street, in which the conductors are placed. This channel has a slot in its upper part, through which communication is established with the motor on the car. The additional cost of equipping a mile of tramway with the central conduit system beyond that of the overhead trolley plan would exceed, according to Mr. Pearson's report, £5,000, and the annual charge for maintenance would also be larger. The Committee are of opinion that before embarking upon any large expenditure, or coming to a final conclusion as to the mode of applying electricity, or the character of the rolling stock to be employed, it is desirable that a trial should forthwith be made with one part of the Liverpool system. For this purpose the Committee ask authority from the Council to enter into arrangements for laying and equipping a system of electric traction from St. George's Church to the Dingle and Prince's Park *vid* Park Lane and St. James's Street, with the overhead trolley. The Committee select this route as it will not interfere with the working of any of the other lines in the city, which must for the present be continued by horse traction; and the Committee are advised that no fair trial of mechanical power can be conducted on lines which are at the same time partly used by horse traction. By this means the public will have an opportunity of forming an opinion as to the advantages or otherwise of the system. The effect of overhead wires could also be better appreciated, and, at the same time, a means be afforded for instructing a staff for the management of mechanically propelled cars. The probable cost of equipping this section and the necessary relaying of the rails is estimated not to exceed £50,000, of which £25,000 would be expended on the track. Mr. Cunningham recommends the adoption of the overhead trolley, but Mr. Harris, who discusses the question of track, refrains from making any recommendation. As the laying and equipping of tramways and the inauguration of a new service with mechanical power are matters of a very special engineering character, the Committee are of opinion that it would be desirable to engage the services of an engineer specially for the purpose. They, therefore, recommend that they be authorised to make arrangements with an engineer to design and superintend the con-

struction of the experimental line, on terms and conditions to be hereafter arranged by the Committee. As the Corporation will take possession of the present tramways on September 1st next, and the Council will, after that date, become responsible for the management of the tramways, the Committee also recommend that they be authorised to carry on the management of the tramways with the assistance, so far as the Committee may require, of the present directors of the tramways company until November 9th next.

New Electric Tramway System.—Most of the leading towns and cities in this country are one by one adopting trolley wires along some of their streets, either with full confidence or as an experiment. There are, however, places where overhead wires would probably not be suffered by the local authority to be fixed in the streets, and with a view to meeting conditions of this nature, we understand that Mr. J. G. W. Aldridge, of 9, Victoria Street, S.W., has spent some time and trouble in devising a system of electric traction which avoids the use of fixed overhead wires. It is also equally independent of slots in the street surface or switch gear in underground boxes. Mr. Aldridge is, we believe, to read a paper upon the subject before the British Association at their Toronto meeting. We are unable, as yet, to express an opinion upon the system, as full details have not yet been disclosed; but in an early issue we may have an opportunity of describing and criticising the method proposed for overcoming the objections to wires fixed in the streets overhead.

Norwich.—The Electric Tramways Bill has passed the Unopposed Bill Committee of the House of Lords. It will be remembered that the Bill authorises the incorporation of a company known as the Norwich Electric Tramways Company, for the construction of over 16 miles of line. The company's capital powers are to be £240,000 in shores and £80,000 in debentures.

Underground Electric Railway.—Lord Morley's Committee of the House of Lords last week passed, as an unopposed measure, a Bill incorporating a new company with powers to construct an underground electric railway from a junction with the Metropolitan and Metropolitan District Railways at Whitechapel, to a junction with the London, Tilbury and Southend Railway at Bromley. The authorised share capital of the company is £660,000, with £220,000 borrowing powers. The Bill has now been sanctioned by both Houses.

Walsall.—On 29th ult., one of the cross-bars supporting the overhead tramway wires gave way, and the wire came down with it for a distance of 40 or 50 yards. No one was injured. The same day the Mechanical Engineers from Birmingham visited the line.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro (Brazil)	July 22nd, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Zanzibar-Mombassa	July 13th, 1897 ...	...
Cyprus-Latakia	July 23rd, 1897 ...	...
Aden-Zanzibar	July 28th, 1897 ...	...
Communication to Vancouver	July 24th, 1897 ...	July 28th, 1897.
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian landlines—		
Omsk-Tomsk	Aug. 2nd, 1897 ...	...

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be sent in plain language.

April 21st, 1897. — The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

Halifax and Bermudas Cable.—Mr. Hanbury had the following notice on the paper for yesterday:—"Submarine Telegraph Contract (Bermuda and Jamaica) (Resolution).—That the contract dated August 2nd, 1897, entered into with the Halifax and Bermudas Cable Company for the construction, laying, and maintenance of a submarine cable between Bermuda and Jamaica, be approved."

Pacific Cable.—A New York despatch, dated 30th ult., says that H.M. surveying vessel, *Penguin*, has arrived at Honolulu, and reports having struck a reef off Palmyra Island. She is stated to have been making surveys at the time in connection with the proposed Australian cable.

CONTRACTS OPEN AND CLOSED.

OPEN.

Brighton.—August 16th. The Council invite tenders for the supply and erection of a complete double-tube surface-condensing plant and water cooling towers, capable of dealing with 40,000 lbs. of steam per hour. Specifications and forms of tender may be obtained on application to the Town Clerk at the Town Hall on payment of one guinea.

Carlisle.—August 19th. The Corporation want tenders for boilers, mechanical stokers, dynamos, storage battery, switchboard, boosters, arc lamps, feeders, mains, &c., for the electric lighting undertaking.

Derby.—August 30th. The Corporation want tenders for the supply of one alternating current dynamo and engine, also a continuous current dynamo for the present engine. Electrical engineer, Mr. J. E. Stewart. See our "Official Notices."

Ludlow.—September 1st. The Corporation of Ludlow offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. Town Clerk, Mr. John Herbert Williams. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in commission.

Port Elizabeth.—September 21st. The Town Council invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town to private houses, stores, &c., for terms of 5, 15, 20, 25 or 30 years respectively.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Sedgfield.—August 7th. The Durham County Asylum Visiting Committee want schemes and specifications for the electric lighting of Winterton Building at Sedgfield Asylum, 500 to 560 16-C.P. being required for that structure and a greater number for the main building. Particulars from Mr. Crozier, County Engineer, Shire Hall, Durham.

Sofia.—September 22nd. The Secretary of State for Foreign Affairs has received a despatch from the Acting British Consul-General at Sofia, stating that the municipality of that town invite tenders for—(1) The supply of electric current to light the streets as well as public and private buildings in the town and the supply of electric power; and (2) The construction and working of electric tramways in the town and suburbs. Tenders will be received at the offices of the municipality of Sofia. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

St. Pancras.—August 9th. Tenders for the supply of Welsh and other steam coal for use at the Regent's Park and the King's Road electricity stations for nine months, for the Vestry of St. Pancras. Average about 100 tons per week. Particulars upon application at the Electricity Department Offices, 57, Pratt Street, Camden Town, N.W.

Switzerland. — September 25th. Tenders are being invited by the Municipal Authorities of Lausanne for the concession for the establishment and working of a central electricity supply station in the town. Tenders to be sent to, and particulars may be obtained from, Le Conseil Municipal de Lausanne.

CLOSED.

Belfast.—The City Council last week accepted the tender of Messrs. J. & W. Stewart for the erection of buildings for the proposed electric lighting station, and that of Messrs. Victor Coates and Co. for steam pipes and pumps.

Halifax. — Mr. T. P. Wilmshurst, borough electrical engineer, informs us that the following tenders have been accepted in connection with the Halifax electric tramways:—

(1) Rails.—The Leeds Steel Works.
(2) Poles.—J. Spencer & Co., Wednesbury.
(3) Mains.—The Callender Cable Co., London.
(4) Bonds, Insulators, and Trolley Wire.—The Electric Construction Co., Wolverhampton.
(5) Generators and Car Equipments.—The Electric Construction Co., Ltd.
(6) Accumulators.—The Chloride Storage Co., Clifton Junction.

Harrow.—The tender of Mr. Frank Johnson, of Chelmsford, has been accepted for the extension of the electric lighting station at Harrow-on-the-Hill for the Harrow Electric Lighting Power Company, the price quoted being £1,600.

Hull.—For certain work to sub-stations in Albion Street and Argyle Street, at £429 odd, the tender of Mr. Mark Harpur has been accepted.

NOTES.

Lord Kelvin on Inflammable Hair-wash.—Lord Kelvin writes as follows to the *Times*:—As a warning that may possibly be useful in preventing the recurrence of any such terrible accident as that which recently happened through the ignition of an inflammable hair-wash, it ought to be generally known that the faintest electric spark suffices to ignite an inflammable mixture of a combustible gas with air. This is illustrated in elementary lectures on electricity by "Volta's cannon"—a little varnished brass gun, mounted on a glass pillar, and having a wide touch-hole plugged with sealing wax, in the centre of which is mounted a brass wire carrying a little brass knob outside and projecting inside to within $\frac{1}{10}$th of an inch of the end of another brass wire fixed to the metal of the gun. The gun is filled with an explosive mixture of oxygen and hydrogen, and its muzzle is plugged with a cork. The varnished outside is struck with a piece of catskin, and, thus electrified, the gun is left insulated on its glass pillar. To fire it, all that is necessary is to touch the projecting knob with the finger. This causes discharge of the electricity by two exceedingly faint sparks, one barely if at all perceptible by the finger before contact with the knob outside, the other in the $\frac{1}{10}$th of an inch air space within the explosive mixture inside. A loud explosion is heard, and the cork is projected with sufficient violence to tear a canvas picture if it chances to touch one. Ignition of vapour of benzine by electric spark is well known to dyers in their process for cleaning silks and other fabrics by boiling in large cauldrons of liquid benzine. When the goods are taken out of the cauldron and spread out to dry on a table, explosions have often taken place, and I believe it is quite certain that an electric spark, caused by some slight friction between dried or partially dried portions of the fabrics, is the incendiary. We all know how readily electric sparks, visible in the dark, and perceptible to the ear by slight crackling sounds, are produced by drawing a hand over very dry hair, or the teeth of a comb through it. In the recent inquest it was stated that the merit of the hair-wash was that it dried so readily. The hairdresser said he felt the hair warm in his hand, and immediately after that all was enveloped in flames. The fact that the hair seemed warm to the hand was due not to the beginning of some kind of spontaneous combustion, as must, I believe, have been imagined by many readers of the report. It showed merely that the part of the hair touched had quickly become dry. Very slight friction of the hand on the dry hair would suffice to produce an electric spark; and the explosive atmosphere of air mixed with combustible vapour, from the portions of the hair not yet dry, was there. The conclusion of the inquest shows that no gas was burning in the neighbourhood, and that no lucifer matches were lying about on the floor which could have been ignited by being trodden on. A gas flame within a yard or two of the place would certainly have been dangerous, but far less apt to produce the disaster than an electric spark from the hair in the very place of greatest liability to the presence of an explosive mixture.

Obituary.—The death occurred on June 27th of Prof. de Volson Wood, of the chair of mathematics of the Stevens Institute of Technology, Hoboken, N.J. He was 65 years of age. The *Scientific American* says that he was professor of civil engineering at the University of Michigan for 15 years, after which he received a call to the chair of mathematics at Stevens Institute, and later to the chair of mechanical engineering. He was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and of the American Association for the Advancement of Science. He was the first president of the Society for the Promotion of Engineering. He was the author of many text-books on mechanical engineering.

Appointments Vacant.—The Leith Town Council want a resident electrical engineer at £300 per annum. Application to be lodged with the Town Clerk by August 16th.

The Torquay Town Council want an engineer-in-charge, engine driver, stoker, cleaner and arc lamp trimmer, and a jointer for house connections, for the electric lighting installation. See our "Official Notices" for particulars.

Labour Disputes.—*Engineering* of the 30th ult. gives data, from which it appears that in 1896 the export of telegraph wire from Great Britain amounted to 56,368 tons, the United States exported 38,043 tons, Belgium 5,383 tons, and France 2,010 tons. The export from Germany, amounting to 209,979 tons, deserves special attention, as this figure is nearly $3\frac{3}{4}$ times the export of Great Britain. In these days of labour disputes, figures like the foregoing are instructive to this country. In face of them, increasing wages, while diminishing the work done, does not appear a sane proceeding, as any benefit gained must be ephemeral. When to these handicaps is added an interdict to the introduction of labour saving machinery, the summit of folly would seem to be reached. The German present success is largely due to a class of designers, inventors and organisers, who are growing up in that empire. In Great Britain, this class has been *facile princeps*, and during their reign British labour has greatly profited. The day of this advantage seems waning, and the demands of the labour section of the community are overweighting the brains which have given to Great Britain her supremacy. Leaders can deal with knaves, but to deal with the foolish, without pandering to their vices, is next to impossible, as no known rules govern their action; they float about indefinitely until starvation, the only thing they will, because they must, recognise, becomes a stern reality. There is no difficulty in bringing these views home to everyone, but the continual temptation of temporary advantage is too great for many. Let us hope that the tempters are only ignorant, and do not wilfully lead their fellows to slow self-destruction in order to further their personal ambition by mounting on the labourers' shoulders.

Correction.—In the article on "High Speed Self-lubricating Steam Engines," for the word "coils" at end of line 27, page 173, read "evils."

Researches on Ionisation.—It has often been pointed out that, according to the dissociation or ionisation conception of the constitution of a solution of an electrolyte, the difference between the physical properties of one in which ionisation is complete and those of the solvent must be compounded additively of the differences produced by the two ions. It would seem to be equally obvious that, in the case of solutions in which the ionisation is not complete, the differences referred to must be similarly compounded of those produced by the undissociated molecules, and by the free ions; and if so, it should be possible to express the numerical values of the various properties in terms of the state of ionisation. Such an expression would take its simplest form in the case of solutions so dilute that the molecules, dissociated or undissociated, might be regarded as sufficiently far apart to render mutual action between them impossible, and in these circumstances the change produced in the properties of the solvent by the undissociated and the dissociated molecules respectively might be expected to be simply proportional to their respective numbers per unit of volume. In a paper on the relation of the physical properties of aqueous solutions to their state of ionisation, by Prof. J. G. MacGregor, of Dalhousie College, Halifax, Nova Scotia, the author endeavours to test the applicability to sufficiently dilute solutions of such an expression, $P = Pw + k(1 - a)n +$ lan, where P is the numerical value of any property (density, &c.), Pw that of the same property of water under the same physical conditions, n the molecular concentration of the solutions, *i.e.*, the number of gramme equivalents, a the ionisation coefficient, and $(1 - a)$ consequently the numbers of dissociated and undissociated gramme equivalents per unit of volume respectively, and k and 1 constants, which may be spoken of as ionisation constants, which will vary with the solvent, the substance dissolved, the property to which they apply, the temperature, and the pressure, but not with the concentration of the solution. The formula can, obviously, apply only to properties for which Pw has a finite value. Thus it is inapplicable to electrical resistance, for which Pw would have a practically infinite value. But our readers will find this paper *in extenso* in the *Transactions* of the Nova Scotian Institute of Science, Vol. ix., Session 1896-97, pp. 219 to 245. It is of too mathematical a character for consideration here.

Shock Fatality at Bristol.—On Friday last a most regrettable accident occurred at the Electric Lighting Station, Bristol, by which one of the employés, a man named Coleman, met with his death. The main cable from the alternators to the switchboard are I. R. insulated, and up to the present time have been run in wood casing and capping, the side fillets of which are ⅞ inch wide. All the casings run in a trench under the floor level. The work in hand was the removal of this wood case and capping, which was to be replaced by Doulton ware casing, the work being carried on only on cables which were not alive at the time. To allow of a particular alternator being used and to prevent the cables of that machine being disturbed over the week end and Bank Holiday, the man Coleman replaced a piece of wood capping over the cables from this machine, but unfortunately it appears that he selected a piece of capping wider than the respective casing, and although he had previously been cautioned only to screw capping on through the side fillets, he made use of an old hole in the capping, some 1½ inch from the edge of the same, and put the screw through the insulation of the cable. Subsequently after the load had been put on these cables deceased came in contact with this screw head, the shock from which caused his death. Artificial respiration was immediately resorted to and kept up for about an hour without avail, the medical man summoned shortly after the accident being of opinion that death had been instantaneous.

The Rebate System.—We have before us a copy of a pamphlet on "Cheap Electricity," which has been published by the County of London and Brush Provincial Electric Lighting Company, and which contains information regarding the sliding scale of charges which this company has adopted for the supply of current in the parishes of St. Luke, Middlesex, and St. James and St. John, Clerkenwell.

Water Power.—A new company has just been formed in St. Petersburg with a capital of 3,500,000 roubles to put down plant to utilise the water power of the Buoksa River and Falls in Finland for the generation of electrical energy.

La Sociedad Electroquimica de Felix is the title of a company which has lately been formed at Barcelona with a capital of £48,000 to erect and work an electro-chemical factory, and to put down plant to utilise the water power of the Felix Waterfalls.

The Institution of Junior Engineers.—The summer meeting, which is to be held in Ireland, meets from August 14th to 17th at Dublin, and 18th to 21st at Belfast. Full particulars may be obtained from the Secretary, 47, Fentiman Road, London, S.W.

Copper.—Despatches from Houghton, Michigan, state that on Thursday, 29th ult., five drill holes in the six mile shaft were blasted, with the result that seven tons of earth were broken one ton being native copper. This is estimated to be three times richer than the Calumet or Hecla mines, which paid dividends amounting to $49,850,000 in less than a quarter of a century.

Personal.—We understand that Mr. R. A. Dawbarn has been appointed superintending engineer of the Brush Electrical Engineering Company in succession to Mr. W. Geipel, whose retirement we recently announced. Mr. Dawbarn has had a wide experience of electric lighting and power schemes, and has been awarded premiums for competitive municipal projects on several occasions.

The Dynamos Didn't Burst!—The *Surrey Advertiser*, in a painfully detailed account of the fire at the I.E.S. Company's works at Woking, says:—

> It was nothing short of providential that a number of dynamos stored in the building failed to explode, otherwise the damage to surrounding property would probably have been enormous.

Who can imagine with what feelings of awe the Surrey writer surveyed these divinely protected dynamos! Perhaps it would be unkind to say that he could not tell an engine from a dynamo, or a boiler from an accumulator. But this paragraph makes us suspicious as to the extent of his knowledge of things electrical!

Wireless Telegraphy.—Signor Marconi in an interview with the *Daily Mail* says that the new company which has been formed to exploit his invention issues stock to the amount of £100,000, of which Mr. Marconi takes half and in addition £10,000 in cash.

NEW COMPANY REGISTERED.

The Randall Telephone Syndicate, Limited (53,529).—Registered July 29th with capital of £50,000 in £1 shares, to adopt an undescribed agreement, and to manufacture, purchase, sell and deal, in telephonic and telegraphic apparatus, machinery, materials, appliances, tools, &c. The subscribers (with one share each) are:—J. L. Cooper, 120, St. Paul's Road, Camden Square, N.W., cashier; J. Perry, 175, Essex Road, Islington, N., clerk; H. J. Bethell, 96, Winkfield Road, Wood Green, clerk; A. E. Seamer, 7, Park Place Villas, W., writer; W. J. Jennings, 20, Abchurch Lane, E.C., secretary; A. Hill, 11, Montholme Road, Wandsworth Common, clerk; H. Adams, 111, Mayall Road, Herne Hill, clerk. The number of directors is not to be less than three or more than five; the subscribers are to appoint the first. Registered by Goldring & Philips, 20, Abchurch Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hooper's Telegraph and India-Rubber Works, Limited (40,947).—This company's annual return was filed on June 18th. The capital is £50,000 in £10 shares (1,000 preference). All the preference and 1,050 ordinary have been taken up, and the preference are considered as paid; £10 per share has been called on 550 ordinary, and £6 per share on the others, and £8,500 has been paid.

Reading Electric Supply Company, Limited (35,651). This company' annual return has just been filed; 4,706 shares have been taken up out of a capital of £75,000 in £5 shares, and £23,530 has been called and paid.

Thomas Parker, Limited (40,973).—This company's annual return was filed on July 22nd, when a capital of £75,000, in £10 shares, was fully taken up. 1,750 shares are considered as paid, and £10 per share has been called on the others. £51,506 has been paid, and £5,994 is in arrears.

English Electric Carbon Company, Limited (38,434).—This company's annual return was filed on July 1st, when 905 shares were taken up out of a capital of £10,000 in £10 shares, and paid for in full.

Electric and General Investment Company, Limited (31,506).—This company's annual return was filed on July 21st. The capital is £200,000 in £5 shares (100 founders'), and 20,000 ordinary and all the founders' shares have been taken up. £1 per share has been called on the ordinary, and £5 per share on the founders', resulting in the receipt of £20,500.

Reuter's Telegram Company, Limited (1,909 C).—This company's annual return was filed on June 16th, when 11,839 shares were taken out of a capital of £100,000 in £8 shares, and paid for in full.

Telegraph Manufacturing Company, Limited (23,482).—This company's annual return was filed on July 12th, when the capital of £50,000, in £10 shares, was taken up in full. 646 are considered as paid, £10 per share has been called on 3,297, and £2 per share on 1,057, resulting in the payment of £35,403.

CITY NOTES.

The Glasgow Corporation Electricity Accounts.

The results of the working for the 12 months ending May 31st, 1897, show a profit of £7,293. £4,300 is devoted to interest on loans, and £1,466 is appropriated to sinking fund, leaving a balance on the year's operations of £1,527, which is transferred to the credit of the Gas Account to meet the deficit in connection with the Electricity Department for the year 1895, which was borne by the Gas Department. The quantity of electricity sold during the past year to private consumers was 1,287,418 units, being an increase of 45·2 per cent. over the preceding year. This increased consumption, so say the Committee, is largely due to the demand during the latter months of the financial year, when the benefit of the rebate under the present system of charging had been recognised by consumers. Considerable extensions are being made to various parts of the system to meet the expected large demand of next winter.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£146,600	—
Number of units sold	1,497,842	—
Number of lamps connected	—	—
Revenue from sale of current	£30,201	—
Net revenue	£7,294	—
Average price obtained per unit ...	5·4d.	—

Cost of Production.	£	s.	d.	Per unit
Coal	2,841	0	0	·45d.
Oil, waste, water, and engine room stores	437	0	0	·07d.
Salaries and wages at generating station	2,336	0	0	·37d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,877	0	0	{Works' cost 1·35d.} ·46d.
Rent, rates and taxes	1,605	0	0	·26d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,930	0	0	·31d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£12,026	0	0	1·92d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	30,201	0	0	5·4d.
Meter rents, &c.	212	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Total	£30,413	0	0	5·4d.

Total cost per unit (exclusive of depreciation and renewal accounts), 1·92d.; works' cost, 1·35d.

Anglo-American Telegraph Company, Limited.

THE half-yearly meeting of the members of the above company was held on July 30th, at Winchester House, Old Broad Street, Sir Gerald Fitzgerald, K.C.M.G., the deputy-chairman, presiding in the absence of Mr. F. A. Bevan (the chairman).

Mr. T. H. WELLS (the secretary) having read the advertisement convening the meeting, the report was taken as read.

The CHAIRMAN said that the previous evening he received a telegram from Mr. Bevan saying that he was suffering from a bad sore throat, and therefore he was unable to preside. It therefore fell to his (Sir Gerald Fitzgerald's) lot to propose the adoption of the report, and he considered himself most fortunate in being able to place before the shareholders accounts which showed continued improvement in the traffic receipts. That increase amounted to £5,935 as compared with the corresponding period of last year, and it was an indication that both on this side and in America there was a steady expansion of trade, which they hoped would not be interfered with in consequence of the recent tariff legislation which was now passing through Congress. He was happy to say there was no indication of that up to the present time, as the traffic receipts for July exceeded those of the corresponding month of last year by something like £1,000. That was very satisfactory. They would observe that there had been a decrease of £3,727 in the expenses, and £3,000 of that was due to the absence of repairs to any of their cables, and the remainder was owing to the care and economy with which their lines had been worked, and for both the increase in the receipts, and the decrease in the expenses, they were indebted to the exertions of their able staff. They would be glad to hear that their ship, the *Minia*, had earned £8,455, as against £2,400 during the same period last year, and that enabled them to carry forward an unusually large balance. On that he would remark first, that this was an interim dividend, and they would deal finally with the balance at the end of the financial year. The large balance arose entirely from the money earned by the *Minia* in repairing cables for another company, and was therefore an extraordinary profit. As a matter of fact the ship should have been employed perhaps in repairing their own 1880 and 1873 cables, the former broken in three places, and the latter having a slight flaw; but holding as they did an interest of 55 per cent. in the pool, they were just as much obliged to see that their partner's cables were in good working order as their own. Therefore, having a larger number of cables than their partner's, they postponed mending their own. He might say that the repair of the Western Union cable in mid-Atlantic in 2,500 fathoms of water, was effected in the shortest time on record, and they had received from the Western Union Company a high appreciation of the promptitude in the matter of time and economy with which the work was done. As far as he could learn, that was characteristic of Captain Trot's general manner of conducting operations entrusted to him, whether by his own company, or by companies employing their ships. As regarded the state of their own cables, they had already, he was glad to say, mended the flaw in their 1880 cable near Newfoundland, and the ship at the present moment was at Valencia, repairing the second flaw. In the repair near Newfoundland they had to put in more than 30 miles of new cable, owing to the fact that they had at an early stage in the life of the cable inserted some cable manufactured in 1869, so it was not surprising that after 28 years it should have been impossible to recover it, and it had to be abandoned. Coming to the renewal fund, he wished to say that since he had been on the board he had given a great deal of consideration to the business of the company and its requirements. They had not only a large and valuable traffic of their own to deal with, but also a predominant interest in the traffic of their partners, and if they wished to preserve those traffics they must maintain their cables in such a state of efficiency that they might not only carry their own traffic, but those of their partners in case of interruption, so that none of it should go to competing companies. He could not shut his eyes to the fact that their 1873 and 1874 cables, which were the same type as the 1869 cable, were old and out of date, and they might be called upon at any time to replace one, or possibly both of them. Their ship *Minia* was also old, and it could not be very long before they would have to procure another one. Under those circumstances he could not too emphatically express his opinion, formed after mature consideration, that their renewal fund was not yet an adequate one, and that it would be wise policy on the part of the board to strengthen it whenever they could do so out of extraneous profits. In the revenue accounts they would notice the donations that the directors had made to the Sir John Pender Memorial Fund, the Prince of Wales's Hospital Fund, and the Diamond Jubilee Celebrations Committee at Newfoundland. With reference to the law suit against the French Cable Company, their lawyer informed them that the Pouyer Quertier advocate had not yet filed his answer, and until he had done so it was impossible to proceed with the case. The net result of their operations for the half-year was an increase of 2s. 6d. per cent. on the ordinary and of 5s. per cent. on the preferred stocks for the six months. Their prospects for the current half-year appeared good. There had been a satisfactory increase of traffic in July, and the directors hoped that when they met them next half-year they would have a good report to make.

Mr. CHARLES BURT seconded the motion, and after some discussion the report was adopted.

Edison & Swan United Electric Light Company, Limited.

A MEETING of this company was held at Cannon Street Hotel on Friday last, Mr. J. S. Forbes presiding.

In moving the adoption of the report, the CHAIRMAN remarked that they said little in it, because one of the difficulties of a business where competition grew from day to day was the great advantage to a private trader to know what the public company with whom he was competing was doing. The profit and loss left a balance of £34,950, and after meeting the debenture interest, &c., there was £29,584 available for distribution. They recommended a dividend for the past half-year at the rate of 6 per cent. per annum, making, with the interim dividend, 5½ per cent. for the past year, as compared with 5 per cent. previously, carrying forward £8,493, against £5,352. During the year they had amalgamated with the Manchester company, to which they had paid a considerable sum of money in shares, and they had undertaken obligations in relation to that company's work which were not sufficiently developed to enable them to form a very safe opinion upon what the result might be, although they had every reason to believe that the bargain would turn out a good one. It was obvious, however, that the broader their base the more they could stand the depreciated selling price of the lamp, because so large a proportion of the expenses of the business was in fixed charges. Their business during the past year had been largely extended, and considerable additions had been made to the shops and plant. On the transactions of the year they had made £7,324 more profit, the amount carried to the profit and loss account last year having been £27,526, as compared with £34,850 this year.

Lord LICHFIELD seconded the motion, which was carried unanimously.

Elmore's American and Canadian Copper Company, Limited.

THE report of the managing director of Elmore's American and Canadian Patent Copper Depositing Company, Limited, sent out with the balance-sheet for the year ending March 31st, states that the working expenses amount to £144, compared with £110 and £165 for the two preceding years. No directors' fees have been taken out since 1892. The income, including £15 brought forward from previous years, is £663, as against £558 for the preceding year. The accounts show that the assets amount to £86,690, or £519 in excess of the liabilities, after meeting the current expenditure; and in addition the company has a cash reserve of £797, being deposits paid on certain shares which have been forfeited through failure of the allottees to pay the calls thereon. Since the date of the balance-sheet this reserve had been increased by £250, and the calls in arrear reduced to £500, which will be still further reduced very shortly. The form of the accounts is slightly altered from that of previous years, with a view to showing more clearly the exact position, and it has the advantage of reducing the nominal figure at which the patents stand in the balance-sheet. The reduction is effected by ignoring the £70,000 deferred shares issued to the vendors, and which are well known to be valueless, and are, for the most part, already written off by the holders; and by also reducing the nominal consideration given for the patents by the amount of priority shares due to the vendors, but which by mutual arrangement have not yet been delivered. This course leaves the patents standing at £74,576, which was the amount of cash actually paid for them, but does not cancel the company's liability in respect to the vendor's shares. The remaining assets of the company are considered to be worth in the aggregate more than the value at which they stand in the balance-sheet. The reserve is far more than sufficient to meet any possible loss on plant, the greater part of which consists of about 7 tons of Elmore copper cylinders, easily convertible into cash. The rest is made up of £2,777 in cash, £7,632 of remunerative investments, and £408 of good debts. In regard to the investments, the directors are pleased to point out the successful liquidation of the loan in 1893 of £7,000 to the French Elmore Company, which very materially assisted that company at the time, and thus also indirectly promoted our own interests. Since the date of the present accounts the board have realised for cash the unredeemed balance of the securities taken in discharge of the loan, with the result that this company not only has

received back in cash the whole of the capital advanced, but also a further amount in cash, equal, with interest already received, to nearly 50 per cent. bonus. At the present moment, therefore, the total investments stand at £900, whilst the cash account has been increased by £7,831 from the investments realised and interest thereon. This amount will be carefully re-invested. The other Elmore companies engaged in manufacture continue to make satisfactory progress, and the prospects of this company have distinctly improved since the last report was issued in December last. In that report great importance was attached to the new method of rapidly operating the Elmore process. The value of this improvement is becoming more and more apparent by the results attained in the works of the two English companies at Leeds. Whilst it is fully applicable to the manufacture of finished goods, yet it is specially applicable to the refinement of copper, and therefore will find its largest field of application in America. This company has been offered the rights for the U.S.A. and Canada on substantially the same terms as those accepted by the English companies, but there is a practical difficulty in the way of this company utilising the new process independently of the English companies, inasmuch as it would be pretty certain to lead to copper refined in America by the new process being exported to England, which is the chief export market for it, and this, of course, would clash with the English company's rights. To avoid this, it is proposed that this company should come into the amalgamation which it is intended to carry out between the two English companies, namely, Elmore's Patent Copper Depositing Company, Limited, and Elmore's Wire Manufacturing Company, Limited. This company is invited to join them on an exact proportionate equality as to capital, and the board has accepted the proposal in principle, subject to the final details being satisfactory, and as soon as possible the scheme will be laid before the shareholders for their consideration. The advantages of the arrangement are very obvious. The management will be concentrated; the capital of the company will be invested in a strong company properly financed, earning, as the board hope to show, a dividend from the very commencement, and having the benefit not only of the profits from the British trade, but also the benefit of royalties and sales in America, where, according to recent returns, some 300,000 tons of copper were refined last year. Although the report and accounts are issued at the present time for the purpose of information, yet it is not proposed to hold a general meeting until later in the year, when details of the above scheme can be published.

Dublin United Tramways Company, Limited.

The second ordinary meeting of this company was held last week.

The Chairman (Dr. Wm. Carte) in moving the adoption of the report and statement of accounts for the half-year ending June 30th, said:—The accounts shows the result of working for the past half-year, and, under the circumstances, it is satisfactory, as the company is in a transition state, and a large expenditure has been incurred, which will be non-earning until the lines are working by electricity. The receipts from the Dublin United Tramways Company were £17,733 18s., and from the Dublin Southern District Tramways Company £2,648. After deducting mortgage debenture interest, and the payment of 6 per cent. on preference shares, a dividend of 4 per cent. on the ordinary shares is proposed, carrying forward £418 5s. 3d. The power house at Clontarf is approaching completion, and within the next few weeks they expected to have the electrical system in operation from Annesley Bridge to Dollymount, and to continue it with as little delay as possible to Nelson's Pillar, on the north side of the city, and to Haddington Road on the south, to connect with the Dalkey cars.

The report was unanimously adopted.

Central London Railway Company, Limited.

The fourth ordinary general meeting of the shareholders of the above company was held on Wednesday at the office, 16, Great George Street, Westminster, Mr. Henry Tennant (the chairman) presiding.

Mr. R. O. Graham (the secretary) having read the advertisement convening the meeting, the report was taken as read.

The Chairman, in proposing the adoption of the report, after stating that the shareholders numbered over 1,000, said that on looking at the published accounts it would be seen that the expenditure during the half-year had amounted to £338,894, and that added to the amount previously expended gave a total outlay to June 30th last of £1,146,220. Those of them who looked at the accounts would see that the principal item of expenditure had been the payment to the Electric Traction Company of £289,327, mainly on account of works executed by them. They would also notice an item of £23,073, which had been paid for the additional land the directors decided to obtain in order to provide for a larger station at the Post Office than was at first contemplated. At the last half-yearly meeting there was some discussion on a proposal of the directors with reference to obtaining powers to acquire a station site on the north side of Oxford Street. That was a proposal which was made in consequence of their not having been able to arrange with the owner of the property on which the Davis Street Station was intended to stand. He was glad, however, now to be able to state that terms had been agreed upon between all parties concerned, and Davis Street Station and street improvements would be carried out as originally intended. When that arrangement was made, it became unnecessary to proceed with the Bill, and he was glad to say that the arrangement was made before the usual somewhat expensive proceeding of appearing before a Committee of the House of Commons or the House of Lords was entered upon. He, personally, had no particular wish to spend money in Parliamentary contests, when such contests could properly be avoided, and as arrangements were made which they considered satisfactory, the directors were very glad that they were made before an expensive contest in Parliament was entered upon. The requisite notice to property owners in respect to the various properties required at Davis Street had been issued, and the work would be started as soon as possible. From the report of the engineers, it would be seen that the work of constructing the tunnels was making satisfactory progress. There was an important work being done at the Bank Station, and the subways at that place were being pressed on as fast as possible. It was satisfactory to know that that important—and an engineer would say, very delicate kind of work—had been carried through, so far, without accident. On other parts of the work some fatalities had occurred, which the directors, and all concerned, deeply regretted.

Lord Rathmore seconded the motion, and the report was adopted.

Mr. Smith proposed a vote of thanks to the chairman and the directors for their attention to the business of the company during the past six months.

Mr. Hales seconded the resolution, which was carried, and the proceedings terminated.

The Chili Telephone Company, Limited.

Mr. George Keith, in presiding at a meeting of this company held at Winchester House yesterday, said that he had very little to add to what had already appeared in the report. The gross revenue amounted to $610,717, showing a decrease on the previous year of $9,109, and the expenditure during the year was $373,009, showing a decrease of $11,970. This decrease, coupled with the improved value of the dollar, had led to an increase in the sterling of £397. They were enabled to recommend the payment of a dividend for the year of 4 per cent., as in the previous year, and to increase the amount carried forward from £557 to £1,020. The result of the year's working had been very adversely affected by the depressed state of business in Chili. The decrease in the gross revenue was largely due to falling off in sales of electrical material which had arisen from the economies which had become general throughout the country and to the competition of cheap German manufactured articles. Considering the state of the country, it was satisfactory to find that the telephone business showed an increase of 145 subscribers over the previous year. After referring to the extensions and the erection of the new multiple switchboard the chairman moved the adoption of the report, which was adopted.

The City of London Electric Lighting Company, Limited.—The following returns are issued by this company for the quarter ended June 30th, 1897:—Gross revenue from sale of current for public lighting, quarter ended June 30th, £3,155, corresponding quarter last year, £3,189; gross revenue from sale of current for private lighting, &c., quarter ended June 30th, £23,001, corresponding quarter last year, £16,564; gross revenue from other sources (estimated), quarter ended June 30th, £1,500, corresponding quarter last year, £650; total, quarter ended June 30th, £27,656, corresponding quarter last year, £20,403; increase, £7,253. Equivalent of 8 C.P. lamps connected on June 30th. 1897, 270,898, increase during quarter, 9,962; equivalent of 8 C.P. lamps connected on June 24th, 1896, 215,559, increase during corresponding quarter last year, 8,291.

Crompton & Co., Limited.—The resolution passed at the extraordinary general meeting at Cannon Street Hotel on July 22nd, will be submitted for confirmation to a second extraordinary general meeting at the same place on Monday next, August 9th, at 3 o'clock p.m. The proposals of the directors for the reduction and re-arrangement of the capital will be brought forward for consideration at a later meeting of the shareholders, which will be held after the holiday season.

Stock Exchange Notices.—The Stock Exchange Committee has ordered the undermentioned securities to be quoted in the Official List:—Edison and Swan United Electric Light Company, Limited—Further issue of 10,000 "A" shares, Nos. 89,262 to 99,261.

W. T. Henley's Telegraph Works Company, Limited.—The directors have declared an interim dividend on the ordinary shares for the half-year ending June 30th at the rate of 6 per cent. per annum, and on the preference shares for the same period at the rate of 7 per cent. per annum, both payable on September 1st.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 2st, 1897, were £851; week ending August 2nd, 1896, £1,036; decrease, £185; total receipts for half-year, 1897, £4,517; corresponding period, 1896, £4,524; decrease, £7.

The Liverpool Overhead Railway Company. The receipts for the week ending August 1st, 1897, amounted to £1,555; corresponding week last year, £1,357; increase, £198.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 30th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,517.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, July 28th.	Closing Quotation, Aug. 4th.	Business done during week ended Aug. 4th, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	99 —103	99 —103	100¼	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5 — 6	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	55 — 58	54 — 57 xd	...	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	101½ — 102½	100½ — 101½xd	101¼	100½
3,038,920£	Do. do. Defd.	Stock	...	...	...	10¾ — 10⅞	10⅛ — 10⅜	10⅛	...
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15 — 15½	15⅛	15
75,000£	Do. do. 5 %, Debs., 2nd series, 1905	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3¼ — 3⅜	3¼ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	170 —175	170 —175	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —107	106 —107	106¾	106⅝
224,850	Consolidated Tele. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16 — 1/16	1/16 — 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½ — 10½	9½ — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	103 —106%	103 —106 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9⅜ — 10½	9½ — 10	9 13/16	9⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 — 17½	16½ — 16¾xd	17	16 13/16
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19 xd	18⅜	18
89,900	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	103 —106	101 —104 xd	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	128 —131	128 —131	130	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	7%	17⅜ — 18¼	17½ — 18	17⅝	17⅝
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 —103	99 —103	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	130 —133	128 —131 xd	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 —103	99 —103	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —103	100 —103	101	100½
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	105 —108	103 —105xd	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%	107 —110 %	...	...
160,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½ — 12	11½ — 12 xd	11 11/16	11½
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17 — 17½	16¾ — 17¼xd	17¼	16⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10 %	26 — 27	26 — 27	26 5/16	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	54 — 57	54 — 57	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6¾ — 7¼	6½ — 6⅝	6⅝	6⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —110	105 —110	106	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝ — ¾	⅝ — ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	7½	...
3,381	Submarine Cables Trust	Cert	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½ — 4	3½ — 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	5 — 6	5 — 6	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	102½	...
64,256	Western and Brazilian Teleg., Ltd.	10	2 %	3 %	2 %	9 — 9½	9 — 9½	9	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	3 %	5 %	5 %	6⅞ — 7¼	6⅞ 7¼	7¼	6⅞
33,129	Do. do. do. Def. Ord	7½	1 %	1 %	...	2¼ — 2⅜	2¼ — 2⅜	2½	...
382,230	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	101 —104	101 —104	102⅞	...
88,321	West India and Panama Teleg., Ltd.	10	⅛	⅛	1 %	⅞ — 1⅛	⅞ 1⅛	...	...
34,563	Do. do. do. 5 % Cum. 1st Pref.	10	6 %	6 %	6 %	10¼ — 10⅜	10¼ 10⅜	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	7%	104 —108	104 —108	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12½ — 13½	12½ — 13½	13½	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6½	6½
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	9¾ — 10¼	9⅞ — 10¼	9⅞	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	110 —113	110 —113	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½ — 24½	23½ — 24½	24 1/16	...
40,000	Do. do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16⅛ — 17⅜	16½ — 17½	17¼	16⅞
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	10	5 %	5 %	5 %	129 —134	130 —135	133⅜	133
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12⅜ — 13¼	12⅜ — 13¼	12⅝	12 1/16
10,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	6 %	6 %	15 — 15½	15 — 15½xd	15 5/16	15¼
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	15 — 15½	15 — 15½	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8½ — 9	8½ — 9	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	3 %	4 %	5 %	16½ — 17⅛	16½ — 17½	17¼	16⅞
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	15 — 16	15½ — 16½	16 7/16	...
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —122	118 —122	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	16½ — 17½	16¾ — 17½xd	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11 xd	10 7/16	10⅜
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	102 —105	102 —105	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	5 %	7 %	9 %	15 — 16	14½ — 15½xd	15	14½

† Quotations on Liverpool Stock Exchange.

* Subject to Founder's Shares.

‡ Unless otherwise stated all shares are fully paid.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES - *Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, July 28th.	Closing Quotation Aug. 4.	Business done during week ended Aug. 4, 1897. Highest.	Lowest.
20,000	British Electric Traction	10	...	...	...	13 — 13½	13 — 13½	13 7/16	13¼
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	5	2½%	...	...	1⅛— 1⅜	⅞— 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅜— 1⅝	1⅜— 1⅝	1⅜	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	105 —109	105 —109	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	93 — 97	93 — 97	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	10⅛	...
143,106	Do. do. do. £6 paid	10	...	...	...	5⅜— 6¼	5⅜— 6¼	...	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼— 4⅜	4¼— 4⅜	...	...
630,000£	City and South London Railway	Stock	1½%	1 5/16%	1 9/16%	63 — 65	64 — 6	66	65
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ — 2	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2¼— 2⅜	2¼— 2⅜	2 11/16	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	4¼— 4⅜	4¼— 4⅜	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	5⅓%	1⅜— 2	1⅜— 2 xd	2	1 15/16
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2⅜— 3¼	2⅜— 3¼xd	2⅜	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅜— 1	⅜— 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½— ⅝	½— ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½— 19½	18½— 19½	19⅛	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	21	20⅞
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	106	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅝%	2⅞%	12¼— 12⅝	12¼ - 12⅝	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16	15½— 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	39	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜— 11¼	10⅜— 11¼	10⅞	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company, 7 % Preference, of £5, 10¼—10⅜xd.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅝—2.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 9¼—9⅜. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2 per cent. (May 13th, 1897).

THE LIMITS OF SPEED IN WORKING SUBMARINE CABLES AS AFFECTED BY FAULTS OR LEAKS, AND BY THE PROPORTIONS OF THE MATERIALS.

By W. A. PRICE.

1. Suggestions have been made recently, especially by Prof. S. P. Thompson, that the signalling speed of long submarine cables may be improved by inserting artificial faults or leaks. The practical problem of working cables can be dealt with by calculation more exactly than almost any other engineering problem, and it is possible to ascertain without experiment the precise effect of such faults on the signalling.

In transmitting messages through a submarine cable a current of electricity is to be produced at the receiving end varying in such a way that its undulations, read by a conventional code, convey the message. Such a current may be represented as the sum of a number of sinusoidal currents differing in period, amplitude, and phase. Any one of these sinusoidal currents can be produced at the receiving end by a sinsusoidal current at the sending end of the same period, but of different amplitude and phase; and from the assigned values of the period, amplitude, and phase at the receiving end, with the constants of the cable, the values at the sending end are easily calculated. The sum of all the sinusoidal currents thus obtained from the sending end gives a sending current which produces at the receiving end the current desired for the purpose of the message. It is possible to determine a sending current which will convey any message, through any cable, at any speed: and from this point of view, the expression "speed of a cable" has no meaning.

2. To send many signals in a given time involves rapidly alternating currents, and the amplitude of currents of high frequency is reduced in traversing the cable so enormously, that the currents at the sending end necessary to produce alternations of the desired amplitude and period at the receiving end might be so great as to endanger the cable. The limiting speed in working a cable is attained when the current at the sending end, or the alternating electromotive force required for its generation, is the maximum the cable can sustain. The reduction in amplitude of the sinusoidal current between the sending and receiving ends increases with the frequency, and of the different sinusoidal currents, components of the current to be received, that one of the set which has the highest frequency and the shortest period will require, in proportion to its amplitude, the highest alternating electromotive force at the sending end. In determining the limiting speed of a cable, if one component has a considerably higher frequency than any other, the transmission of that component will be the most important quantity to be considered, since if the cable can carry the sending currents necessary for transmitting this component of the required amplitude, it will carry the sending currents necessary for the other components more easily, and the working speed of a cable in this case will be measured directly by a frequency of alternation such that the maximum electromotive force permissible at the sending end will produce a current at the receiving end which is just readable.

3. To illustrate this, fig. 1 shows a simple case of a periodic curve supposed to be traced by the recorder siphon

at the receiving end of a cable. It represents a succession of the letters S and O alternately. It can be resolved into the three components of fig. 2, having frequencies respectively proportional to 1, 3, 9, and amplitudes 20, 3, 2.

Suppose it were required to transmit this series of signals

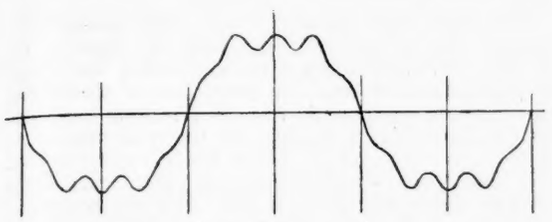


Fig. 1.

through a cable having the following constants :—Resistance 10^{13} C.G.S. units, *i.e.*, 10,000 ohms; capacity, $6{\cdot}10^{-13}$ units, *i.e.*, 600 mfds. These quantities correspond roughly to one of the lighter Atlantic cables. Suppose the delicacy of the receiving instrument to be such that the amplitude of the third component is to be 1 microampere, and the speed to be about 150 letters per minute, *i.e.*, 75 S, and 75 O. The following table shows the currents required.

This speed of signalling with the degree of definition assumed requires a sending E.M.F. higher than would be considered safe.

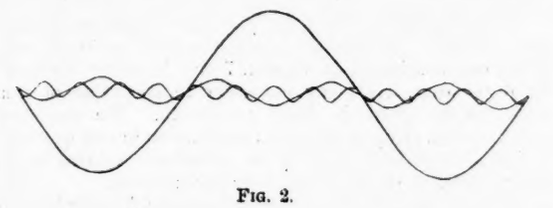


Fig. 2.

If, without changing the form of the curve, the speed were reduced from 150 to 100 letters per minute, the sending electromotive force required for the third component, would be about 38 volts, and if the speed were reduced to 75 letters, only 14·5 volts would be required.

	Amplitude of received current.	Amplitude of sending current.	Amplitude of sending alternating E.M.F.
1st component 75 ~ per min.	10 microamps.	·75 milliamp.	1 volt.
2nd component 3×75 ~ per min.	1·5 microamps.	4·4 milliamp.	3 volts.
3rd component 9×75 ~ per min.	1 microamp.	1·6 ampere.	580 volts.

4. The analytical expressions that determine these results have been given in a convenient form by Mr. T. H. Blakesley. Where R is the total resistance of the cable and K its total capacity, both in C.G.S. units, $\frac{\omega}{2\pi}$ the number of complete alternations per second, we write $\sqrt{\frac{\omega\,K\,R}{2}} = m$. Then the reduction in amplitude between the sending and receiving ends is given by the factor $\left\{\frac{\cosh 2\,m + \cos 2\,m}{2}\right\}^{\frac{1}{2}}$, and the phase is retarded by an angle whose tangent is $\tanh m \,.\, \tan m$. In the case of long cables m has such values that $\cos 2m$ is negligible compared with $\cosh 2m$, and $\tanh m$ is indistinguishable from unity. The reduction of amplitude becomes then $\frac{1}{2}\,e^{m}$, and the retardation of phase becomes the angle whose circular measure is m.

In the case of the particular cable referred to in Section 3, $K\,R = 6$, while $\omega = 8, 24, 72$ for the three components. m has values 5, 8·5, 15, and the reduction in amplitude of the three are respectively $\frac{1}{2}\,e^{5}$, $\frac{1}{2}\,e^{8\cdot5}$, and $\frac{1}{2}\,e^{15}$. If the current at the receiving end has an amplitude, Q, the alternating electromotive force which produces that current has an amplitude $\frac{Q\,R}{2\sqrt{2}\,m}\,e^{m}$ in C.G.S. units.

5. From this statement of the problem in the case of a highly insulated cable of the usual type, the modification of the result by the insertion of a distributed leakage may be dealt with. Suppose that a large number of small inductive leaks are distributed uniformly along the cable, spaced so closely that they are equivalent to a badly insulating dielectric.

Let the length of the cable be L centimetres, the resistance of the conductor per c/m, r, its capacity per c/m, k, the resistance of the dielectric per c/m, ρ, and the inductance of each leak, l, all in C.G.S. units.

Then, if an alternating electromotive force whose period is $\frac{2\pi}{\omega}$ be impressed on the sending end of a cable, the ratio between the amplitudes of the alternating currents at the sending and receiving ends of the cable is—

$$\left\{\frac{\cosh 2\,p\,L + \cos 2\,q\,L}{2}\right\}^{\frac{1}{2}}$$

where

$$2\,p^2 = \sqrt{b^2 + a^2\,\omega^2} + b$$

$$2\,q^2 = \sqrt{b^2 + a^2\,\omega^2} - b$$

$$a = k\,r - \frac{l\,r}{\rho^2 + l^2\,\omega^2}$$

$$b = \frac{\rho\,r}{\rho^2 + l^2\,\omega^2}\,.$$

The retardation of phase at the earthed, or receiving end as compared with the sending end is $\tan^{-1}$ (tanh p L. tan q L).

In the case where the leaks possess no inductance, $l = o$

$$2\,p^2 = \left(\frac{r^2}{\rho^2} + k^2\,r^2\,\omega^2\right)^{\frac{1}{2}} + \frac{r}{\rho}$$

$$2\,q^2 = \left(\frac{r^2}{\rho^2} + k^2\,r^2\,\omega^2\right)^{\frac{1}{2}} - \frac{r}{\rho}.$$

In the case of a highly insulated cable ρ is very large, and $2\,p^2 = 2\,q^2 = k\,r\,\omega$ the result quoted from Mr. Blakesley in Section 4.

The important point for telegraphic purposes is, as has been pointed out, to keep the reduction of amplitude as low as possible, *i.e.* $\left(\frac{\cosh 2\,p\,L + \cos 2\,q\,L}{2}\right)^{\frac{1}{2}}$ should be as small as possible, which in long cables at quick speed may be taken as equivalent to $\frac{1}{2}\,e^{p\,L}$. The relative advantages of constructing the cable with or without leaks, and if with leaks, whether those should be inductive or non-inductive depends on the value to be obtained for p.

In the case of a highly insulated cable of the existing type

$$\frac{2}{r}\,p^2 = k\,\omega.$$

In the case of a cable with non-inductive leaks

$$\frac{2}{r}\,p^2 = \left\{\frac{1}{\rho^2} + k^2\,\omega^2\right\}^{\frac{1}{2}} + \frac{1}{\rho}.$$

This expression cannot be less than $k\,\omega$, and distributed non-inductive leakage is necessarily disadvantageous.

In the case of a cable with inductive leakage

$$\frac{2}{r}\,p^2 = \frac{\rho}{\rho^2 + l^2\,\omega^2} + \left\{\frac{\rho^2}{(\rho^2 + l^2\,\omega^2)^2} + \omega^2\left(k - \frac{l}{\rho^2 + l^2\,\omega^2}\right)^2\right\}^{\frac{1}{2}}$$

This expression may be made less than $k\,\omega$, and the sending power of the cable improved if

(*a*) $\frac{\rho}{\rho^2 + l^2\,\omega^2}$ is less than $\frac{1}{2}\,k\,\omega$.

(*b*) $\frac{l}{\rho^2 + l^2\,\omega^2}$ is nearly equal to k.

Consider the application of these conditions to a cable whose length is $4{\cdot}10^{8}$ c/m (about 2,200 N.M.), capacity 600

mfds., and resistance 10,000 ohms. Suppose ω to be about 70, a figure corresponding to fairly quick transmission. Then $k\,\omega = 10^{-19}$ nearly. Suppose l to be m henries $= m \cdot 10^9$ units, so that m is necessarily a moderate number. Let $\rho = n$ ohms $= n \cdot 10^9$ units so that n cannot be very small, and may be very large. Then for condition (a)

$$\frac{\rho}{\rho^2 + l^2\,\omega^2} = \frac{n}{(n^2 + 70^2\,m^2)\,10^9}.$$

This cannot be less than $k\,\omega$ unless n is of the order 10^{10}. Then $l\,\omega$ is negligible compared with ρ, which we may write $n'\,10^{19}$ where n' may be a moderate number.

Condition (b) then gives $l = m$ henries, where m is nearly equal to $1{\cdot}5\,n'^2\,10^6$, an impracticable inductance.

If it were possible to make ρ very small, and $k\,l\,\omega^2 = 1$, *i.e.*, $k = \frac{1}{7}$ henry, p^2 would become zero, and the cable would transmit the speed given by $\omega = 70$ without any loss of amplitude, but it seems impossible to obtain a leakage of such low resistance, and high inductance as would give any result approximate to this.

6. In the case where a single non-inductive fault occurs at the middle of a long cable, let the resistance of the fault be n R, R being the whole resistance of the conductor, and write $m = \sqrt{\frac{\omega\,\mathrm{K}\,\mathrm{R}}{2}}$. Then if C_0 be the amplitude at the receiving end when there is no fault, and C the amplitude with this non-inductive fault of resistance, n R introduced at the middle point, we have, where $2\,m\,n\,s = 1$,

$$\mathrm{C}_0 = \mathrm{C}\,\{1 + s + \tfrac{1}{2}\,s^2\}^{\frac{1}{2}}$$

The expression in brackets is always > 1, and decreases as ω increases, so that in this case, as in the case of a distributed leak, the amplitudes of all frequencies are reduced by the insertion of the fault, but those of high frequency less than those of low.

Applying these expressions to the current of fig. 1, and the cable of *Section* 3, the table below gives the amplitudes of the received currents in the case where there is a distributed leak, or central fault of 1, ·1, ·01 times respectively the total resistance of the conductor.

This central leak of no resistance, and five henries inductance, gives an improvement of 6 per cent. on a speed of 150 letters a minute. The resistance of the leak can, however, be increased considerably, up to 30 ohms for instance, or what may be required to obtain the circuit of the desired inductance, without much affecting the improvement in speed.

8. It has been pointed out that with non-inductive leakage, whether uniformly distributed or placed at the middle point, the reduction of the amplitude is less at high frequencies than at low. The proportions of the different sinusoidal components of the received current will be changed by the introduction of leakage, and the small undulations, moulded, as it were, on the general line of the siphon trace, will become, relatively to the whole, more prominent; though the total displacements will be less. This may account for the statement often made, that the occurrence of a fault in a cable is accompanied by improved definition of the signals.

It does not follow, however, that a fault is desirable, or that improvement is to be sought by systematically introducing faults. It would seem, where this improvement occurs, that the relative amplitudes of the different components of the current are not as well proportioned as they might be, and that better definition might be obtained by adjusting them at the sending end without incurring loss of amplitude by leakage in the line.

9. In all these cases the expression that gives the reduction of amplitude consists of two factors, one depending on the resistance and inductance of the faults or leakage, the other being in every case a term ϵ^m where $m = \sqrt{\frac{\mathrm{K}\,\mathrm{R}\,\omega}{2}}$

This second term affects the question of speed much more than the first. A reduction of the first term by 60 per cent. in the case considered in Section 7 only improves the speed by 6 per cent, while any reduction in the value of K R improves the speed in direct proportion. We may then examine what prospect there is of a reduction in this quantity, which is determined solely by the materials employed in the construction of the core, and their arrangement.

It seems clear that for single submarine telegraph lines no

Amplitudes of Received Currents.

	No leakage.	Distributed leak. R.	Distributed leak. ·1 R.	Distributed leak. ·01 R.	Central fault. Resist. R.	Central fault. Resist. ·1 R.	Central fault. Resist. ·01 R.
1st component. 75 ~ per min.	10 m/a	9·5 m/a	6·1 m/a	·04 m/a	9·5 m/a	6·25 m/a	1·28 m/a
2nd component. 3 × 75 ~ per min.	1·5 m/a	1·46 m/a	1·17 m/a	·067 m/a	1·44 m/a	1·05 m/a	·31 m/a
3rd component. 9 × 75 ~ per mid.	1 m/a	·998 m/a	·86 m/a	·20 m/a	·98 m/a	·83 m/a	·32 m/a

7. In the case of an inductive leak whose resistance is ρ, and inductance, l, placed at the centre of a long cable, we have

$$\mathrm{C}_0 = \mathrm{C}\left\{1 + \sqrt{\frac{\mathrm{R}}{2\,\omega\,\mathrm{K}}}\,\frac{\rho - l\,\omega}{\rho^2 + l^2\,\omega^2} + \frac{\mathrm{R}}{4\,\omega\,\mathrm{K}}\,\frac{1}{\rho^2 + l^2\,\omega^2}\right\}^{\frac{1}{2}}$$

C_0 being as in the last section the received amplitude when there is no leak, and C when the leak is inserted, so that the comparison of C with C_0 gives a measure of the improvement produced by the leak.

To give the expression in brackets, its lowest value, $\rho = 0$. when the expression is reduced to the form $1 - x + \frac{x^2}{2}$ where $x = \sqrt{\frac{\mathrm{R}}{2\,\omega\,\mathrm{K}}} \cdot \frac{1}{l\,\omega}$. This has its minimum value when $x = 1$.

If, as before, $l = m$ henries, $\omega = 70$, R $= 10{,}000$ ohms, K $= 600$ mfds., we have $m = 5$ nearly, and $\mathrm{C} = \sqrt{2}\,\mathrm{C}_0$.

Suppose ω' to be the value of ω which will give the same amplitude of received signals with the leak inserted, as we had before without the leak, and p' the corresponding value of p, so that $p\,\mathrm{L} = \sqrt{\frac{\omega\,\mathrm{K}\,\mathrm{R}}{2}}$, and $p'\,\mathrm{L} = \sqrt{\frac{\omega'\,\mathrm{K}\,\mathrm{R}}{2}}$ we have $\epsilon^{p'\,\mathrm{L}} = \sqrt{2}\,\epsilon^{p\,\mathrm{L}}$ giving $\omega' = 1{\cdot}06\,\omega$.

arrangement can be superior to the one in common use, having an approximately circular conductor centred in a cylinder of insulating material, and that any arrangement of two or more conductors more or less irregularly disposed can only result in great increase of capacity without any advantage.

The relation between the speed, the diameter of the conductor, and the external diameter of the core can be stated simply. If D be the external diameter of the core, and d of the conductor, the resistance of the cable is inversely proportional to d^2, and the capacity inversely proportional to $\log \frac{\mathrm{D}}{d}$. The speed of the cable is proportional to $d^2 \log \frac{\mathrm{D}}{d}$ which has a maximum value when $\frac{\mathrm{D}}{d} = \sqrt{\epsilon} = 1{\cdot}65$ nearly.

If electrical efficiency had alone to be considered all cables should have the same ratio between the two diameters, regardless of the particular materials employed, and all cables of the same insulating material should have the same capacity per mile. Cables have hitherto been laid with much smaller conductors than this rule would give. The last Anglo-American cable, which had a heavier conductor in proportion to its size than any previous long cable, had diameters ·475″ and ·201″, giving a resistance of 1·6 ohms per mile, and a capacity ·420 mfds per mile, with 650 lbs. of copper and 400 lbs. of gutta-percha. For the same size of core the

above rule would give ·288″ for the diameter of the conductor, giving 1330 lbs. of copper, and a resistance of ·82 ohms per mile, and 308 lbs. of gutta-percha, with a capacity of ·722 mfds per mile.

The ratio of the values of K R in the two cases is 1·19, showing an advantage of 19 per cent. in speed in the second arrangement. With copper at 7d. per lb. and gutta-percha at 5s. per lb., the second is slightly less expensive.

The thickness of gutta-percha, ·0935″, indicated by the formula $\frac{D}{d} = \sqrt{e}$, is too thin for the mechanical conditions of cable laying. With India-rubber this would appear not to be the case, as perfectly durable India-rubber cables, capable of standing rough treatment, are made for electric lighting purposes with heavier conductors and thinner insulation than this.

The use of India-rubber would, moreover, give a further increase of about 10 per cent. in speed in consequence of its lower specific electrostatic capacity. An India-rubber cable with core of the same external dimensions might have an advantage of 31 per cent. in speed over the last Anglo-American cable.

ELECTRICITY V. SHAFTING IN THE MACHINE SHOP.*

CHAS. H. BENJAMIN, Cleveland, O.

This is a sequel to Prof. Benjamin's paper at the December meeting on "Friction Horse-Power in Factories." The tables give quite a complete summary of his investigations, and with his conclusions, are sufficient to get an idea of the case in the instances cited.

Table I.

Number.	1 Total line shaft, in feet.	2 Diameters of line shafts, inches.	3 Number of belts.	4 Average width of belts.	5 No. of machines.	6 No. of men.	7 Total horse-power.	8 Horse-power to drive machines.	9 Horse-power to drive shafting.	10 Useful horse-power per machine.
1	130	2½ 2¾ / 4 6	89	4	..	...	400	243	157	...
2	580	3 3½	28	6	18	78	74	17	57	...
3	530	2½ 3	53	5½	43	152	38·6	13·3	25·3	·310
4	1,460	2½ 3 4	92	4½	69	80	59·2	11·3	47·9	·164
5	1,120	3	141	4	68	300	112	48	64	·707
6	1,065	2 3 4	192	4	123	225	168	77	91	·627
7	748	1½ 1¾ / 2 3	217	3	250	200	40·4	19·7	20·7	·790
8	500	2 3	335	3	313	226	74·3	34·3	40	·109
9	990	1¾ 2½	217	3	258	100	47·2	22·7	24·5	·881
10	2,490	2 6	521	3	454	400	190	82	108	·180
11	1,472	2 3 4	484	3	179	350	107	32·5	74·5	·181
12	1,800	2 2¼ / 2½ 3	486	3	428	320	241	127	114	·296

He says: "In estimating the cost of generators and motors for these same shops, it is assumed that a generator will be required having a power 50 per cent. greater than the net power used by the machines when the shop is running at full capacity, and that the aggregate power of the motors should be double this. It is further assumed that the motor unit will be from 5 to 10 horse-power in the shops doing heavy work, and not less than 2 horse-power in the shops doing light work. The cost of electric motors may be roughly classified as follows:

Horse-power of motor ...	2	3	5	10	20	40	50	65	75
Cost in dollars per H.P.	65	60	45	35	25	20	17	16	15

The figures in column 2 of Table II. thus show what might reasonably be expected as to the cost of generators and motors for each establishment. No account has been made in the one case of the cost of countershafts and secondary belting, nor in the other of conductors, switches, and such countershafts as might be used, one omission being allowed to offset the other.

* New York *Machinery*.

Column 3 shows the differences between the values in the two preceding columns, the + sign indicating greater first cost for electricity, and the − sign greater first cost for shafting transmission. It will be noticed that in general the electrical transmission has the greater first cost, but in establishments where the amount of shafting is out of all proportion to the useful work done, electricity has the advantage even here. (See shop No. 4.) In shops like Nos. 10 and 12, the machinery is compactly arranged and the cost of shafting relatively light.

Table II.

Number.	1 First cost of shafting and belting.	2 First cost of generator and motors.	3 Difference in first cost.	4 Horse-power lost by electric transmission.	5 Horse-power lost by shafting transmission.	6 Net saving by electricity. Horse-power.	7 Saving in dollars per year.	8 Pay roll per year (estimated).
1	...	...	...	121	117	No gain.	...	...
2	3,650	7,150	+ 3,500	9	49	40	2,400	39,000
3	3,750	3,000	− 750	7	21	14	840	76,000
4	7,450	2,100	− 5,350	6	42	36	2,160	40,000
5	7,700	7,000	− 700	24	53	29	1,740	150,000
6	8,550	10,950	+ 2,400	39	74	35	2,100	112,500
7	2,700	4,300	+ 1,600	10	16	6	360	100,000
8	4,000	7,000	+ 3,000	17	32	15	900	113,000
9	4,000	5,000	+ 1,000	12	20	8	480	50,000
10	9,650	18,000	+ 8,350	41	89	48	2,880	200,000
11	7,550	7,000	− 550	16	64	48	2,880	175,000
12	8,400	25,000	+16,600	64	90	26	1,560	160,000

If there is any unfairness in the above figures, it is in over-estimating the electrical cost, since the writer desires to be conservative.

The figures of column 4 of Table II. are derived from those in column 8 of Table I., by assuming a combined efficiency of two-thirds for generators and motors. The power lost in shafting transmission, column 5 and Table II., is obtained from column 9 of Table I., by deducting 10 per cent. of gross horse-power for engine friction.

The net gain in horse-power, by using electric transmission, is shown in column 6. Allowing $60 per horse-power per year as the gross cost of power delivered, we obtain the results in column 7 for the saving in dollars per year.

Some one may object that these calculations are rough, and based on insufficient data. Even if we admit this, two facts can still be regarded as proven:

1. That the first cost of electrical machinery is usually greater than that of shafting and belting.

2. *That the saving in power in most machinery establishments would pay for the additional cost of the electric plant in from one to five years.*

A saving of from 2 to 5 per cent. in the pay roll is of more importance than any saving that is likely to be effected in the power plant.

In some shops the power cost represents only about 1 per cent. of the total expense of running.

The question of the advantage of introducing electricity hinges not upon efficiency of transmission, but upon the effect on the output of product per man and per machine.

The different points to be considered in determining how electricity affects general economy of production may be classified as follows:

1. General arrangement of machinery to facilitate handling of work.
2. Clear head-room for the use of electric cranes and small hoists.
3. Light and cleanliness.
4. Control of speed.
5. General flexibility of the system.
6. Use of electricity for other purposes than power.

The whole shop should be planned with a view to handling the product with the least waste of time and labour, and electricity makes this possible. Large machines may be put in any position and at any angle, or, if need be, may be transported from place to place to accommodate the work.

The power plant may be located in the most favourable place for taking care of coal, water, and ashes, and the power distributed to any building or buildings with but little loss.

As another result of our long subjection to ordinary methods of conveying power, we have come to regard a machine shop as necessarily dark, a synonym for all that is black and dingy. A glance at the shops of some of our electrical establishments will convince anyone that this is a mistake.

Shops like those of the Crocker-Wheeler Company, the Westinghouse Company, &c., have been called "show places;" but at least they *show* the way from darkness into light, and should receive credit for it.

The belt is a dust carrier as well as a power carrier, and nothing can be kept clean in its vicinity. When we add to this the shadows cast by the shafts and belts themselves, we have a condition of things which tends to mistakes and poor work, and cannot be without a corresponding moral effect on the workman.

The partial or entire absence of overhead belts, and the diffused light reflected from whitewashed ceilings and walls, will cause an improvement in both quantity and quality of output which will prove a strong argument for electricity.

One of the minor advantages of direct-connected motors on large machines is the possibility of easily and quickly adapting the speed of the machine to the kind of work being done. On large boring mills and lathes, especially when facing up work, this may be a factor of considerable importance in determining the cost of production.

The ease with which the electric system of transmission may be adopted or extended is one of the strongest arguments in its favour. The extravagant consumption of power, as noted in the former paper, is probably due in most cases to a gradual extension of the shafting system by lengthening shafts beyond a reasonable limit, to the turning of corners with bevel gears, and to the use of turned and twisted belts, with their attendant evils in the way of guide pulleys.

The writer has had under his personal observation motors which have run for years whenever called on, have required less care than an ordinary loose pulley, and have cost almost nothing for repairs. An electric motor, if properly designed and constructed, requires no more care than any piece of machinery running at the same speed.

Only lately the writer saw a railway motor driving a grinder for pulverising furnace linings, in an atmosphere so full of grit and dust that the operator had to keep his mouth and nose masked. The motor under a street car will convince the most superficial observer that there is nothing to be feared on this score.

ELECTRICITY IN THE MODERN MACHINE SHOP.

American machine shop practice is more generally noted than is our own for labour-saving contrivances. We do not imply that the best English shops are not fully in line with American shops, but probably the rank and file are behind very largely because of the action of the tyrannical Trades Union in forbidding their men attending to such machines. We should not care to see the nigger-driving practices of American machine shops introduced into England because they are contrary to the national ideas of personal freedom which prevail here, but there is a happy mean to which the Union might attain without any hardship, and which would certainly help us in competition with the sweated foreigner. Mr. Louis Bell contributes to the *Engineering Magazine* an article under the above title. We would be second to none in advocating the use of electricity wherever practicable. Mr. Bell alludes to the first electric motor put up in France, near Paris, to unload beets at a sugar works, and says it saved 40 per cent. upon the old method of unloading. Now, what was the old method? We are not told, nor are we told how near the wharf was to a source of power.

One would think to read this article that no workshop ever had a power crane or hoist of any description, for so much stress is laid on the saving of time to be made by the use of electrical cranes in a workshop. A square shaft or a flying rope crane will save labour equally with an electrical crane, and one man will as easily work all the several motions.

Where electricity undoubtedly has an advantage is in such a tool as a drill for working on a ship's side to cut, say, portholes. Such a drill can be made to hold itself in position by its magnetic feet, and a similar use for magnetism is referred to as used at the South Chicago works of the Illinois Steel Company, where boiler plates are required to be moved. These are inconvenient to sling, but are readily picked up magnetically, and transferred down the shop and dropped again. There seems a wide field for the magnetic grip, especially for moderate weights on inconvenient shapes. With large work it is better to fasten a tool to the work in many cases, than it is to carry work to a tool. Obviously this can be best rendered practicable by means of electrical driving, for how else could a portable tool be so conveniently driven. Mr. Bell does not advocate the too extended use of magnetic contrivances on machine tools for the purposes of automatic action in clutches and cut-offs. They need to be used with great caution, as contacts get rough, and it is desirable that frequent repetitions of a single small motion should be effected by mechanical means. Electric motors are useful where delicate speed control is wanted, as this can be more closely arranged than by stepped pulleys or other means. Such control can be had with a shunt-wound motor and a capacious rheostat in the field circuit, if assisted, say, with a three-speed cone pulley. One of the neatest of devices is the electrically-heated soldering iron. Such a tool is always at the right temperature, and an ordinary soldering iron is, except at one brief moment, either too hot or too cold. When used to solder up full cans of kerosene, they obviously saved the previous necessity of heating the irons in a room other than that in which the work was done.

The author doubts and properly the moral effect of electrical driving on the men. Is it indeed likely that a turner will pay any attention to the driving of his lathe by belt or electricity. He can as easily move the belt as the switch. After all, the great labour saving of electricity comes in its lighting power. By electricity alone can good light be secured, either by inverted arc lamps and overhead reflectors or the conveniently portable incandescent lamp. Good lighting is one of the most important aids to effective labour that can be placed in a workshop. Next probably comes the portable tool. An emery wheel held like a barber's rotary brush would do much of the work now done with files, as in the first stages at least of key fitting.

The obvious uses of electricity are so numerous, that to claim its universal applicability is unwise. Our author does not go far wrong along this line, unless in the case we have already alluded to in respect of cranes. In these machines electricity saves power rather than time, for the daylong rotation of a square shaft, or the friction of a flying rope, are saved when electricity is the motive power, and only needs expending when actual movement is to be effected. But too little is made of this and similar points, and too much of electricity as a wonderful agent for lifting purposes, as though no workshop ever before had a power crane of any description.

REVIEWS.

The Calculus for Engineers. By John Perry, M.E., B.Sc., F.R.S. London: Edward Arnold, 37, Bedford Street.

This book describes what has for many years been the most important part of the regular course in the Calculus for mechanical and electrical engineering students at the Finsbury Technical College. Any work written by Prof. Perry must command something more than respect, and the present one certainly deserves commendation. The free use of numerical tests to establish the correctness and significance of a formula is strongly insisted upon. In our opinion this is a point of inestimable value, and one which should be carefully followed out. There was perhaps no greater defect in the style of teaching of past years than that of underrating the value of numerical examples, or rather of not seeing the value of the same. Prof. Perry has the courage of his opinions when he states, "The result of a false system of training is seen in this, that not one good engineer in a hun-

dred believes in what is usually called "theory." We heartily agree with him. A feature in the book is the delightfully colloquial style of the writer, a style which would make the pedantic professors of old turn in their graves, as being most grossly out of place and unbecoming in a mathematical treatise. The very thought of the calculus is a terror to many, but Prof. Perry, in his book, has certainly done much to soothe those who allow themselves to be frightened by what is to a great extent a self-conjured-up bogie. The title of the book is, perhaps, a little misleading, as by "engineers" many would not include "electricians," for whom the work is of great use, as a very large number of the problems dealt with are purely electrical.

We can very heartily recommend Prof. Perry's book.

The Induction Coil in Practical Work. By Lewis Wright. London: Macmillan & Co.

The writer of this book is not unknown to the scientific world, he being the author of several other works dealing with the subject of "Light," "The Microscope," &c. There are already several very good books in existence dealing with the subject of induction coils, and although Mr. Lewis' production is a good one, it does not very materially advance our knowledge of the matters dealt with. It is curious that Mr. Lewis seems ignorant of the very common arrangement of coils with a central division, as on page 44 he suggests it as if it were a new idea; at the same time it does seem somewhat strange that it is not more universally adopted than it actually is, seeing the advantage of the arrangement and the very slight extra cost it involves; most of us know how exasperating a broken "inside end" is. Mr. Lewis' explanations are not always very clear; for example, on page 45 in speaking of the "condenser" he first says there is no necessity in arranging so that both coatings of the condenser can be disconnected, and then immediately afterwards he says that the effect is different if only one coating is disconnected. A useful addition (which we have never seen adopted) to the more expensive coils would be a simple form of ammeter; as a rule, one is in perfect ignorance of the current used to excite a coil. Mr. Lewis, in suggesting the use of dry batteries for small coils, states that these are recharged like ordinary storage cells, a statement which is very far from the truth, though not, perhaps, absolutely untrue. The delusion that *pure* zinc, if used in batteries, would not require amalgamation, is a widespread one, and has only a faint basis of truth, but Mr. Lewis believes in it, as the result of hearsay only, we expect; we recommend him to make a few experiments on the subject; he will probably be mightily pleased at the results, and the next edition of his work would, we think, appear with the note at the foot of page 32 omitted.

Practically, three-fourths of the work contain little if anything which will not be found in other treaties on the same subject; the last portion, however, which deals with X rays, is a good compilation of what has been done in this direction, and is of considerable interest and value.

A good feature in the book is the series of well-executed illustrations.

Electromoteurs et Leurs Applications. By G. Dumont, Ingénieur des Arts et Manufactures. Paris: Gauthier-Villars et Fils, and Masson et Cie., Boulevard Saint-Germain.

To produce a treatise on electromotors without any restrictions as to the size of the book or its price would be a comparatively easy matter, and there may be many electrical engineers competent to undertake such a work. M. Dumont has, however, imposed upon himself the more difficult task of covering the subject of direct and alternating current motors in a volume containing only 183 small pages at the very low price of 2fr. 50c.

In such a work we cannot expect to find a complete treatment either of the theory of electromotors or of their mechanical design, and we are left to surmise for what class of readers the book is intended as the difficulties of the reviewer are enhanced by the absence of a preface. The book is divided into six parts, which are further subdivided into chapters.

Part I. enumerates the various methods employed in the transmission and distribution of power, and draws a comparison between electrical and other methods.

The first five chapters of Part II. are devoted to a concise and simple treatment of the properties of series, shunt, and compound-wound direct current motors, and their respective advantages and disadvantages are discussed. Chapter 5 deals with speed regulation of motors, and contains an account of the devices employed to stop them quickly—*arrêt instantané.* Chapters 6—10 of this part treat of alternating current motors and of the principles involved in their working and manipulation. The various types—monophase, diphase, and triphase—of motors are described, and particular attention is drawn to the Stanley and Kelly, the Elihu Thomson, and the Brown machines.

Part III. consists of one short chapter on the systems of distribution of electrical energy, while Part IV. shows the superiority of electrical over mechanical means of transmitting energy in many cases.

Part V. is an abstract of a paper read by Mr. Crompton in 1895 before the Institution of Electrical Engineers on the power absorbed by various cutting tools driven by electromotors. Part VI. gives the applications of electromotors in the distribution and transmission of power.

M. Dumont has succeeded in producing a work which could be suitably be recommended to those who wish to have a simple explanation of the electrical principles involved in the working of electric motors. The simplest mathematics is employed, and the calculus is sedulously avoided. Results which cannot be deduced without the help of more difficult analysis are simply stated, and may generally be taken as correct. Rotary magnetic fields are treated in a way that is liable to lead to a misconception of the actual state of things. In a triphase motor, for example, the resultant intensity is deduced on the assumption of three simple periodic fields represented by $H \sin \omega t$, $H \sin \left(\omega t + \frac{2\pi}{3}\right)$ and $H \sin \left(\omega t + \frac{4\pi}{3}\right)$ respectively, and leads to a uniform field of strength $\frac{3H}{2}$, rotating with a constant angular velocity. The three component fields cannot be rigorously treated in this way. The only accurate way of determining the intensity is by a consideration of the resultant ampere turns producing it. Determined in this way the resultant field is seen to be not of constant strength, but subject to small periodic variations.

As a whole, M. Dumont's book is a really good introduction to the subject of electromotors and their applications, which anyone possessing a knowledge of the laws of induced currents will be able to peruse with profit and interest.

Minutes of Proceedings of the Engineering Association of New South Wales. Vol. IX. Sydney.

This society now numbers 140 members, and is doing very useful work, the papers read and the discussions thereon being of a decidedly high class. It is gratifying to find that the colonies are doing so well in this respect.

Journal of the Institution of Electrical Engineers. No. 127. London: E. and F. N. Spon, 125, Strand.

The general contents of this number are as follows:—Discussion on Mr. Hollin's paper, "Electrically Interlocking the Block and Mechanical Signals on Railways." Paper on "The Relative Size, Weight, and Price of Dynamo-electric Machines," by E. Wilson, member.

FATAL ACCIDENT AT THE BOURNEMOUTH ELECTRIC SUPPLY STATION.

The following report has been presented by Major Cardew to the Assistant Secretary, Harbour Department, Board of Trade, on the subject of the Bournemouth accident:—

"I have the honour to report that, in accordance with your instructions, I have inquired into the facts connected with the death

of J. Morris, engine fitter's labourer, at the Bournemouth electric supply station on the 6th inst.

"I attach an extract from a local newspaper giving a report of the proceedings at the coroner's inquest.

"The case appears to be quite simple, and in my opinion the death of the man was certainly directly due to electric shock.

"On the 6th inst. Morris was assisting Edward Sackman, a fitter by trade, putting in gas fittings.

"For this purpose it was necessary to drill holes in certain iron columns to which the gas brackets were to be fixed.

"These columns are of channel section, and stand slightly in front of the wall of the building to which the various switches and apparatus for regulating the electric power are fixed.

"The men had fixed one fitting and had nearly finished drilling a second column, when Sackman left work somewhat hurriedly just before the dinner hour, as he was troubled with toothache. He states that before leaving he warned Morris to be careful not to accidentally touch any of the high pressure apparatus. After dinner Morris started to drill another of these columns which was adjacent to certain 'synchronising switches.' These switches are so constructed as to expose the metal portions which are liable to be, and evidently at the time were, charged to high pressure. They are, however, fixed at such a height that persons standing on the floor would not be liable to make contact with them, the lowest portion of the metal exposed being at a height of 6 feet 6 inches from the ground.

"The switches are operated by means of cords, and under ordinary conditions would be considered safe.

"Morris, however, had to work at some height from the floor level, and for this purpose brought a short ladder and fixed it against the wall. As he stood on this ladder his head was level with the switches, which were only 10 inches distant from the column.

"Morris started to drill from the back of the column, and he must have tried to get his head in such a position as to see his work, and thus have brought his right temple into contact with the upper portion of the switch while holding on to the metal of the column with his left hand. The current which must have passed through his brain would, under these circumstances, as the electric pressure was over 2,000 volts, have been sufficient to cause instant death.

"In this unfortunate case the fault appears to me to be attributable chiefly to the carelessness of the man who lost his life. He had been for many years in the service of the Electric Supply Company, and had been often employed in work connected with the high pressure supply, and without doubt was aware of the danger of touching any portion of a high pressure system.

"I must, however, point out that he was a man of imperfect education; that at the time he was engaged upon mechanical work totally unconnected with the electric supply; and that his attention being occupied with his work, he may very possibly have been entirely oblivious at the time of the fact that he was surrounded with danger of a peculiarly latent and incomprehensible nature.

"The engineer in charge at the time should, I consider, have carefully supervised the operations of this man whilst he was engaged on mechanical work in close proximity to high pressure apparatus.

"The case, in fact, is very analogous to the fatal accident in January of last year to a workman in a transforming chamber at Cheltenham, and my remarks on that case to some extent apply to this also.

"It is also to be noted that the switch with which the man's head came into contact could have been easily discharged without in any way affecting the supply from the station, and as only one machine was running at the time, I consider that it was an oversight to have left this switch charged.

"I would further remark that had a conspicuous 'danger' warning been exhibited at these switches, it is almost inconceivable that Morris would have sacrificed his life.

"I have, &c.,

"(Sd.) P. Cardew, *Major*."

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

17,025. "Apparatus for measuring the phases of alternating currents." J. Tuma. Dated July 19th.

17,029. "Improvements in or relating to electric lighting." O. P. Macfarlane. (R. J. Crowley, France.) Dated July 19th.

17,032. "Improvements in and connected with the utilisation of electrical energy as the heating agent in the melting apparatus of linotype machines." The Linotype Company, Limited, J. Place, and M. Barr. Dated July 19th.

17,075. "Improvements in collectors applicable to electric railways or tramways, and the like." H. S. Cowx. Dated July 20th.

17,081. "Improvements in and connected with electrical furnaces." F. J. Patten. Dated July 20th. (*Complete.*)

17,092. "Improvements in or relating to electro-depositing devices." J. Bossard. Dated July 20th. (*Complete.*)

17,099. "Rheostats." O. H. Pieper and A. F. Pieper. Dated July 20th. (*Complete.*)

17,105. "Improvements in primary batteries." W. J. L. Sandy. Dated July 20th.

17,113. "Improvements in underground systems of electrical distribution." W. L. Wise. (A. S. Krotrz, P. Allen, and O. S. Kelly, United States.) Dated July 20th. (*Complete.*)

17,142. "Improved electro-mechanical apparatus for the control of electric motors." J. Dulait. Dated July 20th.

17,143. "Improved automatic braking mechanism for electric cars and the like." J. Dulait. Dated July 20th.

17,158. "Improvements in electric batteries." W. Rowbotham. Dated July 20th.

17,266. "Improvements relating to the starting switches of electro motors." F. G. Robinson. Dated July 22nd.

17,315. "An improved process for electrolytically purifying and filtering saccharine liquids or solutions." C. A. Meygret. Dated July 22nd.

17,316. "Improvements in accumulators." L. G. Garcia. Dated July 22nd. (*Complete.*)

17,319. "Improvements in plates for secondary batteries." W. J. S. Barber-Starkey. Dated July 22nd.

17,331. "An improved casing for electric wires." R. Pearson and G. D. Dennis. Dated July 22nd.

17,333. "Improvements in and connected with apparatus for lighting and extinguishing gas jets by means of electricity." W. Whittington and H. B. Sheridan. Dated July 22nd.

17,386. "The electro-submersive amalgamator." A. A. Lockwood Dated July 23rd.

17,390. "Improvements in or connected with commutators for dynamo-electric machines and electric motors." C. J. Ferguson. Dated July 23rd.

17,425. "Improvement in telephones." H. Godsal. Dated July 24th.

17,426. "An improvement in electro-magnetic motors." J. P. Jones. Dated July 24th.

17,431. "Improvements in ceiling roses for electric lamps." A. Watson. Dated July 24th.

17,434. "Improvements in electro-mechanical devices for producing corresponding positions in transmitting and receiving apparatus." A. Barr and W. Stroud. Dated July 24th.

17,451. "Improvements in portable electric lighting apparatus.'. A. Richter. Dated July 24th.

17,470. "Automatic transformer switch apparatus." A. Schlatter. Dated July 24th. (*Complete.*)

17,471. "Improvements in electrical furnaces." C. D. Abel. (Siemens & Halske, Germany.) Dated July 24th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps*).]

1896.

3,092. "Improvements in controllers for electric motors." J. D. Devonshire. (W. B. Potter, U.S.) Dated February 11th, 1896. The invention relates to controllers for electric motors, and its object is to so arrange a controller that it may be adapted to give a greater number of combinations by which the speed of the motor may be regulated than has heretofore been the case. It also combines with the controller mechanism which in its ordinary operation it may be actuated from its lowest to its highest position giving the motors a certain number of changes or commutations and by then throwing a switch the manual operation may be repeated, combining the motors in different manners and giving different rates of speeds, so that before the switch has been thrown and after it has been thrown the manual operation of the controller is identical but the result in the combinations of the motors are different. 5 claims.

3,481. "Improvements in dynamo-electric machines." S. Z. de Ferranti. Dated February 15th, 1896. Relates to improvements in dynamo-electric machinery and consists in placing insulating strips of iron on the face of the poles and connecting them by means of non-magnetic metal strips in such a manner as to convey a current in a direction contrary to that in which current flows in the armature conductors in order to neutralise the armature reactions. 5 claims.